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It's 25 Days 'Till Christmas

When the joys of youth and manhood intermingle in the giving that we do.

ON CHRISTMAS NIGHT in the section where I was born every member of the family hung up a stocking (Christmas trees were associated with church celebrations) and everybody wrote a letter to Santa Claus. Those who didn't write a letter talked about it so that the effect was the same and somehow from the many things suggested in letters or the ones talked about, everybody got something that they expected and really wanted and so they were happy on Christmas day. One of the things we always asked for and always got because it was an easy request to fill was plenty of nuts, raisins and candy—and as a boy I enjoyed these just as much as anything else I ever received at Christmas time.

Now I've hung up my stocking already and in the letter to Santa I have asked for something like the nuts, raisins and candy that brought gladness to my heart in those childhood days when the more expensive gifts did not mean much. This year I want a letter from every reader of INDUSTRIAL ENGINEER who has got something worth while out of the paper during the year, telling how he has used one practical article or two, or three, in some way to his own benefit in his work. Then I want, next, a suggestion for some new material or information that we have not published, but which you would like very much to get. Then I want you to end your letter with some little expression of good will or Merry Christmas message for the editors (Braymer, Van Brunt, Gooding and Hubert), who have done the best they know how to make you feel that they are working with you and for you in making INDUSTRIAL ENGINEER *your paper*. In a word, let's all of us get better acquainted in the spirit set down by that popular poet, Edgar A. Guest, in these lines:

When you get to know a fellow, know his joys and know his cares,
When you've come to understand him and the burdens that he bears,
When you've learned the fight he's making and the troubles in his way,
Then you find that he is different than you thought him yesterday.
You find his faults are trivial and there's not so much to blame
In the brother that you jeered at when you only knew his name.
When you get to know a fellow, know his every mood and whim,
You begin to find the texture of the splendid side of him;
You begin to understand him, and you cease to scoff and sneer,
For with understanding always prejudices disappear.
You begin to find his virtues and his faults you cease to tell,
For you seldom hate a fellow when you know him very well.

Don't forget the ending to your letter, for I want to pass on to the editors some little expression *from you* like you have so frequently addressed to me personally that will indicate that there truly is "Peace on Earth Among Men of Good Will at Christmas Time."

This much I really want and expect this year for Christmas just as I really wanted the nuts, raisins and candy of those good old days, gone but not forgotten. And to all of you I wish a million things—but above all, health, happiness and prosperity and a very Merry Christmas.

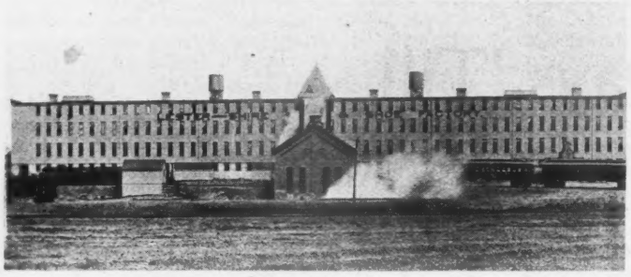
Practical Pete

A Glimpse into the Works of the

Endicott-Johnson Corporation

Where skins and hides are tanned into leather, which is used to turn out 130,000 pairs of shoes daily. The twelfth of a series devoted to the growth and extent of our basic American industries

PERHAPS one of the best examples of factory specialization is found in the boot and shoe industry. Up until well along in the nineteenth century a shoemaker built the shoe or boot complete. It was not until the early part of the nineteenth century that shoes were even made right and left. Today shoe-making is a highly specialized factory industry where each worker does a single operation on a right or a left shoe only. The shoe passes on from operator to operator and machine to machine until completed. Some idea of the extent to which specialization has been carried out is shown by the fact that, depending upon the grade, style and quality, a shoe passes through from 175 to over 200 separate operations. Generally, each of these is performed by a different worker and on a separate and special machine. The invention and production of these special shoe machines alone has developed into an extensive business which has helped make possible the wide substitution of machinery for hand labor in this industry, as well as better and cheaper shoes.



The original plant from which the Endicott-Johnson Corporation has grown.

When this original factory was taken over in 1884 it had a daily capacity of 500 to 600 pairs of shoes. Today the entire organization can produce 130,000 pairs per day. This is now called Johnson City, N. Y., in honor of the present president.

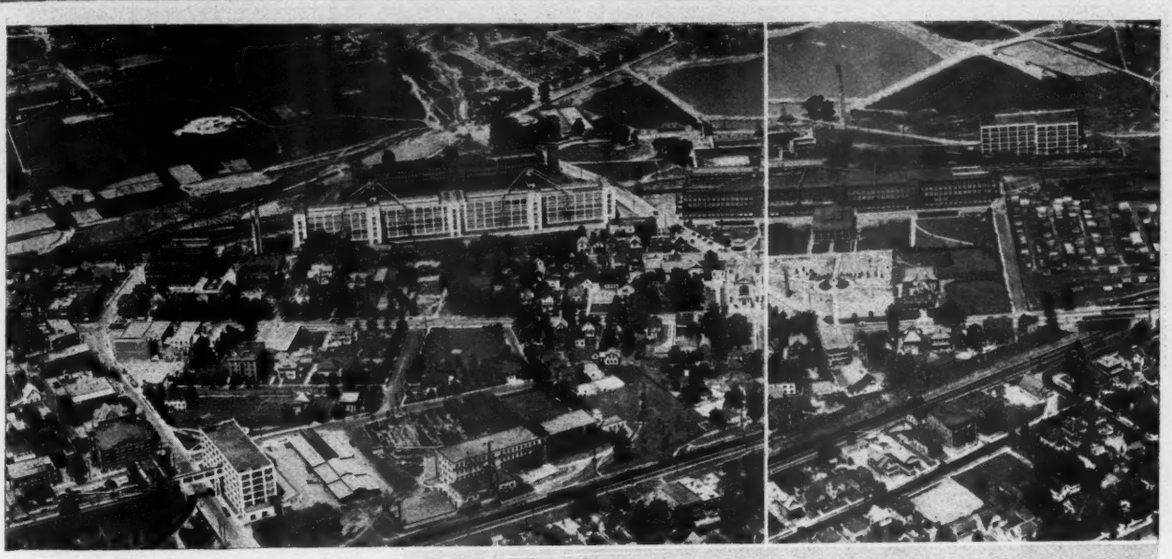
The shoe industry was first established and still largely centers in New England and New York, where in some cases it is the principal industry of entire communities. In recent years additional manufacturing centers have been established in the Middle West, particularly around St. Louis, Chicago and Milwaukee.

One of the largest and most interesting of these eastern boot and shoe industrial communities centers around the plant of the Endicott-Johnson Corporation at the adjacent cities of Endicott and Johnson City, N. Y. About forty years ago H. D. Endicott, now deceased, a young leather dealer, took over the management of a creditor shoe factory employing about 500 workers in Leistershire, New York. Later the name of the city was changed to Johnson City. He chose one of his foremen, George F. Johnson, who is now president of the company, as superintendent.

The business has grown from the small factory shown at the head of this article to be the largest producer of shoes in the world, occupying twelve factories and six tanneries, several of which are shown in the other accompanying illustrations. A good idea of the development of the industry is indicated by the increased output per worker during

A modern factory which replaced the original factory above.

This plant is known as the Corliss Avenue Work Shoe Factory and is the largest of the entire group. The plant has 14.10 acres of floor space, employs 1,400 people, and has a daily output of 26,400 pairs of shoes, or over 18 pairs of shoes per employee. The upper floors of the smaller white building at the right, the Utility Factory, are used for making children's shoes. Shoe cartons and other supplies are made in the lower floors.



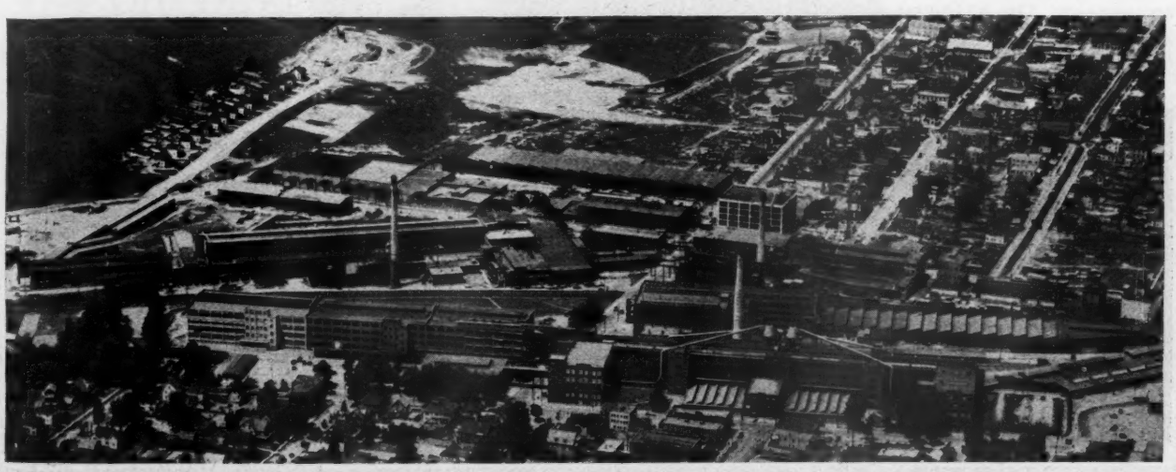
An airplane view of some of the Endicott-Johnson factories in Johnson City, N. Y.

A portion of the Corliss Avenue shoe factory is shown in the lower left-hand corner of the above illustration. The long white building near the center of the illustration, the Victory shoe factory, is said to be the most modern and complete shoe factory in the world, with 2,000 employees, and a daily output of 19,000 pair of shoes. About 19,200 pairs of scout shoes are made daily in the building just back of the Victory shoe factory. The McKay factory, the long dark building at the upper right (another view is shown in the illustration at the right), produces 27,600 pairs of shoes per day, which is the largest output of any of the company's factories. The two-story building in front houses one of four restaurants which serve meals to the employees, at 15 cents each. The white concrete building in the upper right-hand corner makes scrap up into leather cutting block and leather flooring. These views show the parks, lakes, swimming pools, and other features which make the surroundings attractive to the workers.

that time. About forty years ago the 500 workers in the original plant could turn out approximately 500 pairs of shoes a day, or about a pair of shoes per employee. Today the 16,000 employees produce 130,000 pairs of shoes per day which, after eliminating the employes in the tanneries and similar departments, is over ten shoes per day per employee. The boot and shoe industry is the largest user of leather, and to supply these factories six tanneries which produce 20,500 sides of leather and skins per day are grouped around the shoe plants. Five of these tanneries are in Johnson City, N. Y. In addition to leather, 4,100 miles of thread and 14 tons of tacks and nails are used per day. The company also makes the shoe cartons in which each pair

An airplane view of the group of factories at Endicott, N. Y.

The Endicott-Johnson Corporation obtain their leather by tanning raw hides. This group of factories contains the largest single tannery in the world, which produces 6,200 sides of leather daily. Another tannery in this group is devoted to making fine-grade, calf skin upper leather. Altogether the six tanneries have a daily output of over 20,500 sides of leather. Another factory produces daily 22,800 pairs of mens' and boys' dress shoes. One of the buildings also houses the sales department, offices and shipping department, which distributes over thirteen carloads of shoes a day.



Interior views of the sole cutting room and the cutting room of the welt factory.

Cutting the leather so as to give the least amount of waste is one of the important considerations in the boot and shoe industry. The welt is the strip of leather which is sewed around the lower edge of the upper of a shoe. The sole is sewed at its edges to this strip.

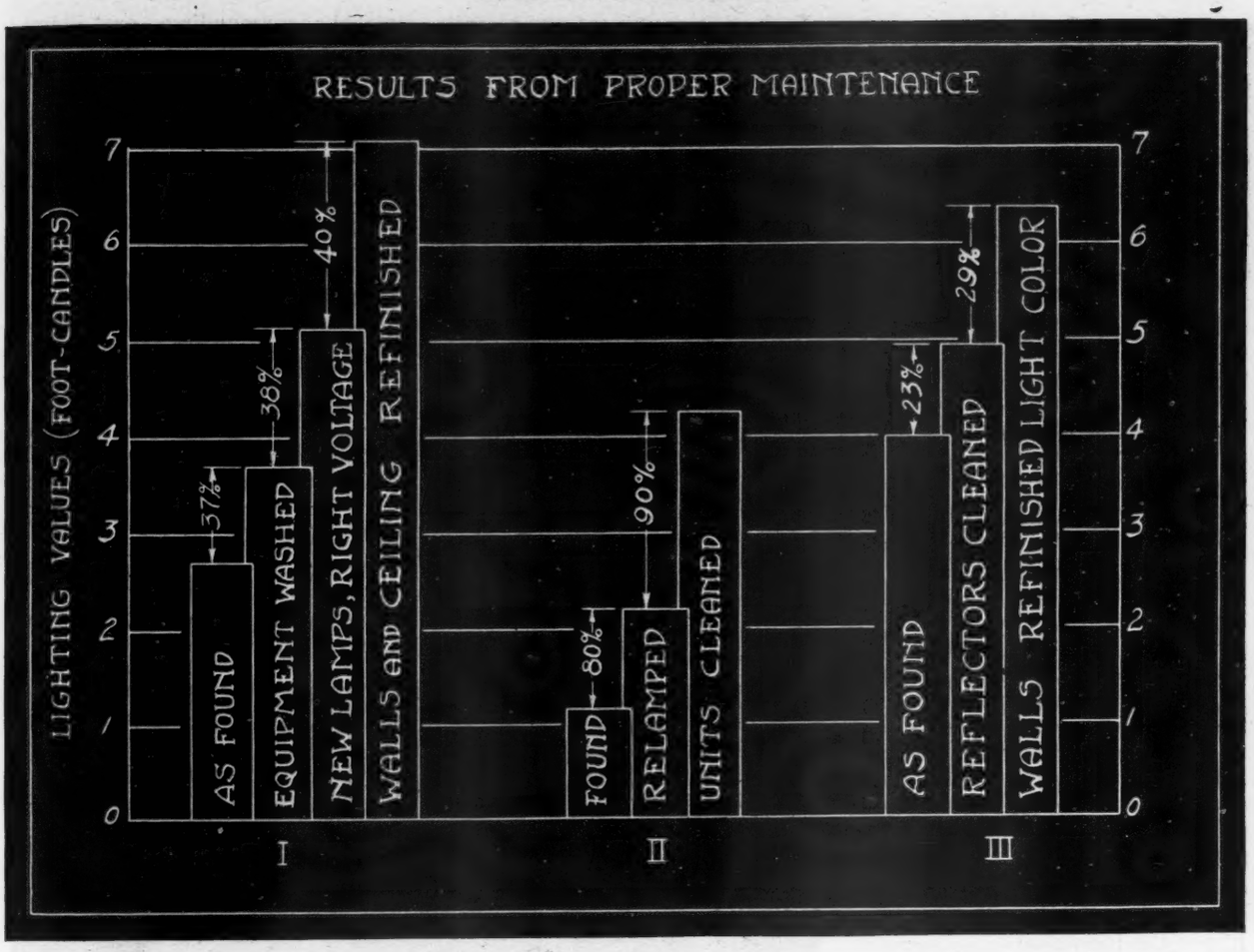
is packed and uses the scrap leather in making leather flooring and cutting blocks.

In addition to the large production of shoes the Endicott-Johnson Corporation is well known because of its liberal employee policies. For example, it was one of the first concerns to recognize the value of steady year-around production and employment instead of a few months of rush, overtime work, followed by periods of idleness. However, each employee gets two weeks' vacation annually with pay and also shares in the profits of the company. Much attention is paid to housing problems and to making the city attractive to the workers by parks, play grounds, and other features. Four company restaurants serve employees meals at 15 cents each.

The entire leather industry of the United States, according to the manufacturers census of 1921, is not large and, including those connected with the tanning of hides and skins, employs only 280,000 wage earners. Of these 49,000 are employed in tanning and 183,500 in the manufacture of boots and shoes, with the remainder engaged in the production of belting, harness, gloves and miscellaneous leather products. In 1921, according to the latest manufacturing census report, the tanneries of the United States produced leather worth $383,000,000. Much of this went into the production of boots and shoes valued at $867,500,000. The total value of all finished leather products was $1,160,820,000. As the boot and shoe industry requires considerable hand labor in production, the cost of materials represents about 60 per cent of the value of the finished product. In the tanning industry, on the other hand, the cost of the raw material represents a much higher percentage, as less labor is expended. Tanning is a process which requires some months and ties up the capital invested during that time. The raw hides are a by-product of the meat-packing industry. Many, however, are imported from other countries.

Three interior views of a shoe factory.

In the stitching department at the right, the pieces of leather which form the "upper" of the shoe are stitched together. In making the daily output of 130,000 pairs of shoes, 4,100 miles of thread are used by the Endicott-Johnson Corporation. In the "lasting" room, at the left below, the uppers of the shoes are shaped over a last and the soles put on. In addition to the thread for sewing on these soles, 14 tons of tacks and nails are used daily. After finishing and inspecting, each pair of shoes is placed in a paper carton. The view below shows the carton-making department. The manufacture of shoes is one of the most highly specialized industries. Making a shoe requires about 200 separate operations made on special machines.



THE ACCOMPANYING illustrations show the transformation resulting from replacing drop cord lighting with bare lamps by large gas-filled lamps in efficient reflectors. These units were spaced as shown in Fig. 5 to give proper direction of light and eliminate dark spots and shadows around machines, which are accident hazards in a factory. The number of lighting units was reduced from 65 to 51 but the watts per sq. ft. increased from 0.6 to 1.0, with an increase of the total wattage of lamps installed from 3,250 to 6,075 watts.

How One Factory Has Benefited by

Revamping an Obsolete Lighting System

And Installing the Proper Lamps and Reflectors to Give Better Distribution and Higher Intensity of Light

By J. J. McLAUGHLIN

Illumination Bureau, Westinghouse Lamp Company

IN going back of the Stone Age, we find that men of that period knew of no light at night except that of the moon and stars, or the blinding flash that broke with a crash from the clouds. When the cave man arose, however, and learned the art of producing fire, he also discovered that it gave light; therefore, the light thus produced made the cave a very haven of refuge from the darkness and unseen terrors of the night outside.

Gradually there came about the torch made of pine knots found in refuse from decaying logs. These small knots, dried and split and fastened in a bundle, burned with a brilliant if smoky light and served to drive away wild beasts, as well as to point out the pathway to and from the cave.

Next came the hunter roasting his game in the fire. He noticed that the fat which dripped into the flame burned vigorously, giving out a great deal of heat and light; so, collecting some drippings in a shell or hollow stone he set it on fire and saw that it would burn of itself and by adding a wick of shredded bark he made the first lamp.

The lamps and candles which

sprang from such simple beginnings were the only form of artificial light for illumination for many centuries. But the necessity for some form of artificial illumination has urged man to develop many kinds of illuminants. Coincident with the invention of the candle there was a greater development of the lamp, because here was an opportunity for an illuminant of a more permanent character. When a candle burns, the candle itself is consumed, but when a lamp burns, it is only the oil in the lamp that is lost. The lamp itself remains. As lamps became larger they gave off more light, but for thousands of years there was no source of artificial illumination that could compare in brilliancy with the sources of today.

The discovery of petroleum in the United States during the middle of the last century and the great supply of "rock-oil" was the beginning of an industry that has covered all parts of the inhabited earth with products that have been used to a great extent as sources of illumination. However, the coming of, and the development in, the use of gas and electricity as sources of artificial illumination, has brought about a change in controllable illumination for the workshop as well as for the home and the social life of the individual.

In the past, when the individual worked at his trade or business, alone, in a corner of a small room or shop of his own, the requirements of illumination called for only the individual source hung close to the work. The small light sources and equipment available in those days would permit the use of only such a method of lighting.

While in these days this method of using the local lighting unit directly over and close to the work is ideal and must be used where the work is fine or exacting, nevertheless, with the development of machinery and the collecting of a number of workmen in one room or shop, bringing about mass production, there has been brought about a need for greater improvement in the lighting of the workshop. The development of larger incandescent lamps has followed this need.

Such an improvement was recently made in one section of the C. T. Williamson Wire Novelty Co.'s plant, located in Newark, New Jersey. In Fig. 1 is shown the old method of suspending bare lamps (small sizes) on drop cords, with no reflectors over the lamps to shield the eyes of the workman. A large portion of the light was permitted to go off in a horizontal direction, whereas a good and properly designed reflector would direct a large percentage of the light on the work and where needed.

This method of bare drop cord lighting has become obsolete and is being replaced by modern and efficient use of large gas-filled Mazda lamps, equipped with efficient types of reflectors. The complete units are spaced and mounted in proper positions so that the workmen will obtain a goodly amount of properly directed light on his work, while at the same time the surroundings are illuminated sufficiently to eliminate darkness and annoying shadows, which are accident hazards in the factory.

Fig. 2 shows the same work bench section as in Fig. 1. Here the improvement over the old drop cord lighting is plainly evident. The former system over the bench consisted of 50-watt Mazda B lamps, bare, suspended on long adjustable drop cords, with key sockets. Most of the working hours these lamps were kept in a low position directly in front of the eyes, thus causing a harmful glare which in time became seriously annoying to the workman. This method also had the disadvantage that the lamp was in the way and the workman lost time in adjusting it to some other position or height. Also, unless the lamps had wire guards to protect them they were often broken, resulting in lost time for the work-

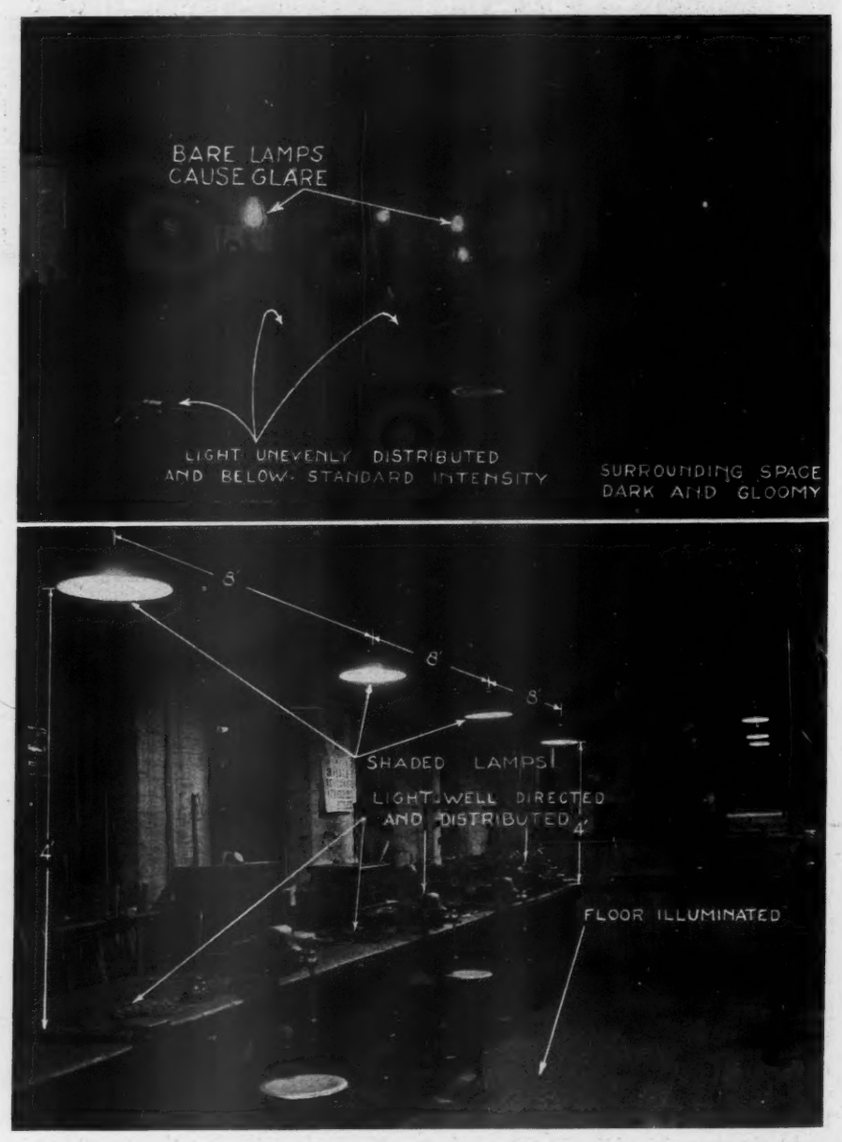


Fig. 1 (Above)—The old local lighting over benches consisted of 50-watt bare lamps on drop cords. Fig. 2 (Below)—New lighting installation replacing that shown in Fig. 1, using 75-watt, Westinghouse Mazda, gas-filled lamps and standard dome, R. L. M. reflectors.

man while without the light, plus the cost of replacing the lamp.

The new installation, as in Fig. 2, shows the lamps at a fixed height of 4 ft. above the top of the bench and spaced on symmetrical centers 8 ft. apart over the outer edge of the bench, thus giving a uniform illumination over the whole working area and the immediate surrounding space. The unit consists of 75-watt, Westinghouse gas-filled Mazda white lamps and Westinghouse standard-R. L. M., porcelain-enameled, steel reflectors.

The same size of lamp and style of reflector is used over other benches in various parts of the room, the location and arrangement of which is shown in the plan of Fig. 5. The method of lighting as illustrated in Fig. 2 is called localized-general lighting. By locating the units over the working positions of the benches and machines, at the same time keeping them well above the workman's head and spaced in a symmetrical manner, there is provided a combination of local and general overhead lighting, with the good features of each system.

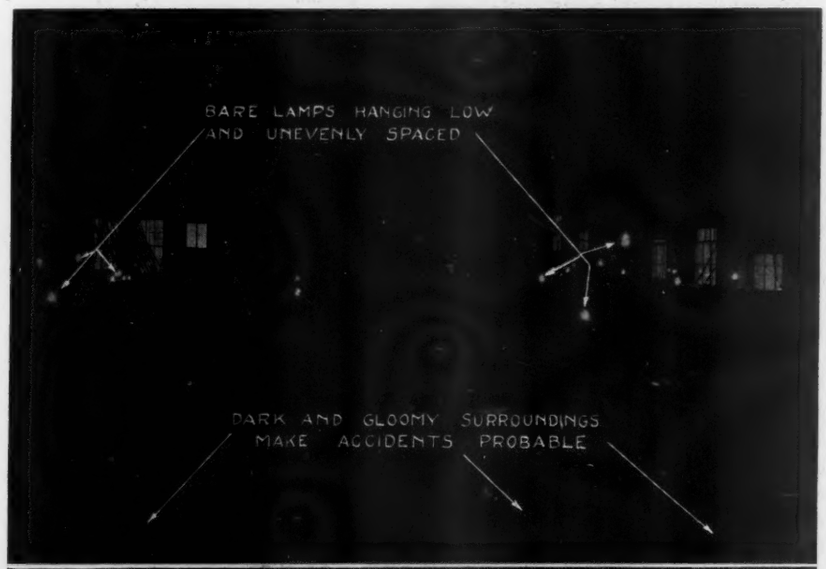
While efficient results can be obtained by localized-general lighting, if properly installed, there are, nevertheless, cases of very fine work in the shop when it is necessary to use a lamp close to the work. In such cases, several factors should be considered; namely, the size of the lamp, the type of reflector, the method of mounting same, and the location. Fig. 6 illustrates in a graphic way an efficient and satisfactory method of installing this type of strictly local lighting unit. The upright supporting arm should be fastened near the back edge of bench so as not to interfere with setting work or tools on the bench, and working at a vise.

The bracket holding the socket, lamp and reflector, should be adjustable to permit moving the light to any desired position. The position shown in the figure permits the reflector (which may be smaller than shown, but never flat or shallow) to direct the light on the work, at the same time shielding the workman's eyes.

Supplementing the work benches along the walls, in the Williamson plant, the room is occupied mostly by automatic machines. In Fig. 3 is shown a general view of the room from one end. This view was taken under the old lighting system; the *lamps*, one may observe, can be seen very readily; however, this can not be said of the *machines*. The lighting units were similar to the old ones over the benches, consisting of 50-watt, bare lamps suspended on drop cords and hanging very low, many were only about three or four feet above the floor; thus from any part of the room glare from the bare lamps was prevalent. The lamps were located in a non-uniform manner, which gave bright spots in some sections and dark areas in others.

The view in Fig. 4 shows the new lighting system consisting of 150-watt, Westinghouse gas-filled, Mazda lamps, bowl-enameled, with Westinghouse standard-R. L. M., porcelain-enameled, steel reflectors. One unit is located in the center of each small bay of 10 by 16 ft. and is mounted 9 ft., 6 in. above the floor. This arrangement of units brought each row over the center of the machine rows, thus directing a large portion of the light on the machines, at the same time illuminating the balance of the floor space well, which can be noted by comparing Figs. 3 and 4.

In the new installation there is a total of fifty-one units as against sixty-five in the old, a saving of fourteen units to be maintained. While this advantage in the number of units was gained through an effi-



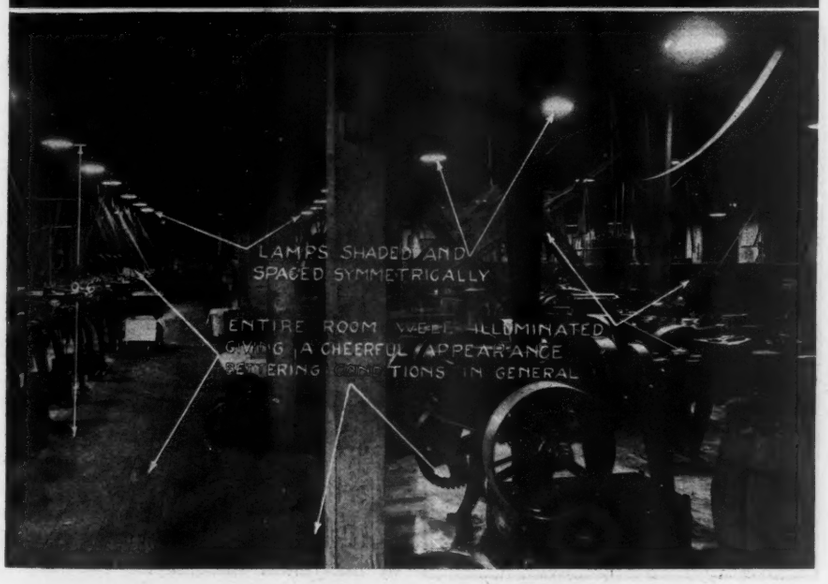


Fig. 3 (Above)—A general view of the shop showing the old lighting units consisting of 50-watt, bare lamps suspended on drop cords at various heights and spacings.

Fig. 4 (Below)—A general view of the shop after the new lighting system was installed, replacing the old system shown in Fig. 3. The new system consists of 150-watt, Westinghouse Mazda, gas-filled lamps, bowl-enameled and standard R. L. M. reflectors.

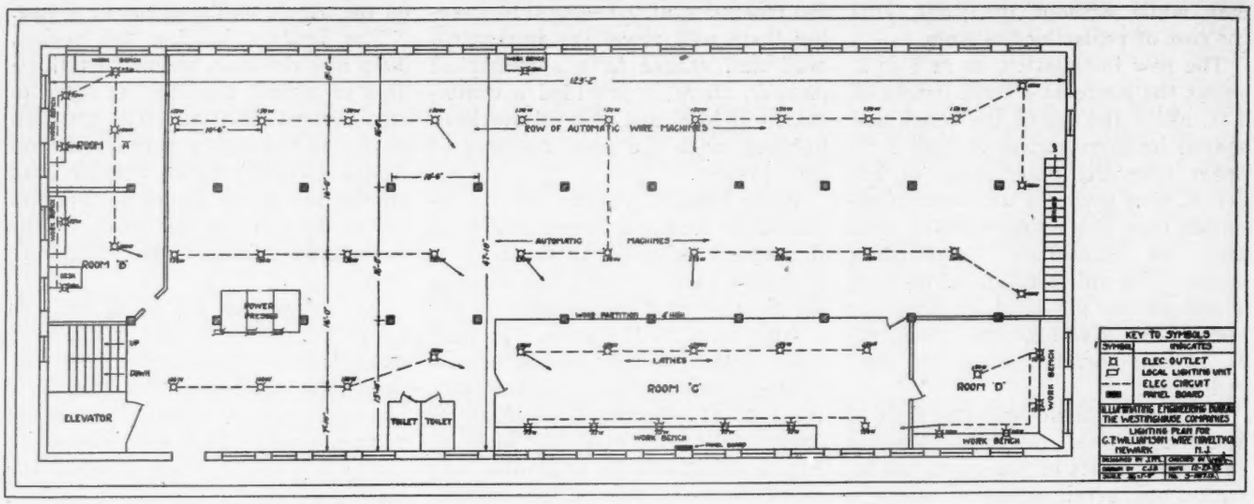


Fig. 5—Floor plan showing new layout of outlets, circuits, and location of control panel board in the C. T. Williamson Company factory.

cient arrangement of the outlets, the average watts per square foot of floor area was increased in the new installation. However, the intensity of illumination increased in a much greater proportion through the use of more efficient lamps and reflectors, and the results and advantages are evident.

In the old installation the sixty-five 50-watt Mazda B lamps represented a total of 3,250 watts or an average for the total floor area of 0.6 watts per square foot. In the new installation using fifty-one lamps in sizes of 75, 100 and 150-watts, the total wattage is 6,075, or an average of 1.0 watt per square foot.

The intensity of light directly under the 50-watt lamps of the old installation was about 20 to 25 foot-candles, but with irregular spacing and the lamps hung low, the intensity at various points between the lamps would drop down as low as 1.0 foot-candle. The main difficulty with the old installation was not that there was an insufficient amount of light on the working plane close to the lamp but it was due to the fact that the lamps were not shaded, were hung low and there was a great amount of glare in the eyes of the workmen, thus reducing their visual acuity and at the same time a large amount of light was going off in other directions than to the working plane. A large portion of the useful light was, therefore, lost, bringing about a low efficiency for the entire system.

In the new installation with the 150-watt lamps, the average intensity was about 8 foot-candles over the working plane. But immediately under the lamps, which in many cases were directly over the machines, an intensity of 14 foot-candles was obtained. In the case of the 75-watt lamps over work benches there was an average intensity of about 15 foot-candles.

In general the advantage that the new system has over the old system is that it provides a fairly uniform illumination over the entire room area, eliminating dark shadows and making it possible to get approximately the same appearance that a daylight lighted room would have.

While the advisability of good natural and artificial illumination is so reasonable that a list of its effects may seem commonplace, these effects are of such importance in their relation to factory operation that they are worthy of careful attention. The effects of good illumination, both natural and artificial, and the influences of bright and cheerful interior surroundings include the following:

1—Reduction of accidents.
2—Greater accuracy in workmanship, resulting in improved quality of goods.
3—Increased production for the same labor cost.
4—Less eye strain.
5—Greater contentment of the workmen.
6—More order and neatness in the plant.
7—Supervision of men made easier.

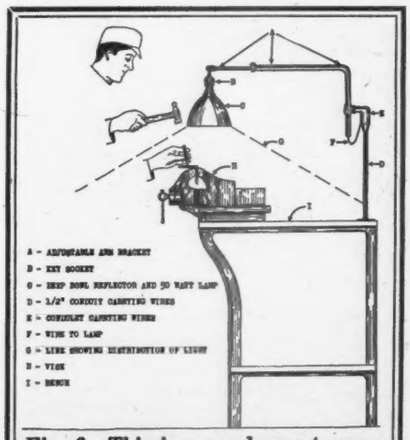

A - ADJUSTABLE ARM BRACKET
B - KEY SOCKET
C - DEEP BOWL REFLECTOR AND 50 WATT LAMP
D - 1/2" CONDUIT CARRYING WIRES
E - CONDUIT CARRYING WIRES
F - WIRE TO LAMP
G - LINE SHOWING DISTRIBUTION OF LIGHT
H - VISE
I - BENCH

Fig. 6—This is a good way to provide local lighting for bench work. The reflector directs the light on the work and at the same time shields the eye of the workman.

While it is difficult to place a definite value on the savings effected in increased production and improved quality by good illumination, it by no means follows that such savings are insignificant or not substantial. The factory owner who ignores them neglects his own interests. Other items in the foregoing list, such as labor turnover, morale, or insurance rates are even more difficult to evaluate, but they are nevertheless real.

Lamps and reflectors should be inspected and maintained regularly, wiped off at least once every two weeks and thoroughly washed once every month. Clean warm water containing ammonia (about half a cup of commercial ammonia to a pail of water) will be sufficient.

In case of equipment that has been neglected for a considerable time, it is advisable first to wipe off the lamps and reflectors with a dry rag and then wash them with warm soapy water and dry them in order to remove the soap film, which would readily collect a fresh coat of dust.

The practical results obtained by sensible attention to lighting equipment are shown in the first diagram. These data emphasize the importance of inspecting and maintaining a lighting system in its state of maximum efficiency.

THIS IS THE FOURTH of a series of articles by Mr. Martindale started in the October, 1922, issue. The first article dealt with troubles arising from the wrong grade of brush; the second which appeared in the December, 1922, issue, took up troubles due to faulty brush operation, and the third, in the March, 1923, issue analyzed defects in a commutator. The next and final article will discuss causes and effects of troubles arising from sources external to the armature.

Some Troubles Caused by

Armature and Field Defects

That Appear at the Brushes and Ways in Which They Can be Corrected

By E. H. MARTINDALE
President, The Martindale Electric Co., Cleveland, Ohio

This illustration shows a simple method of balancing an armature on ways and then applying weights to the light side. This method may be used satisfactorily for all except high-speed armatures.

THIS ARTICLE follows the outline of Section IV of the double-page chart showing brush and commutator troubles that appeared with the first article of this series by the writer on pages 476 and 477 of the October, 1922, issue of INDUSTRIAL ENGINEER. In drawing up that chart, two armature troubles in Section IV were overlooked, namely: (*a*) Short circuits in armature coils. (*b*) Grounded armature coils or commutator bars. The equipment and methods used to locate these defects are similar to those for troubles Nos. 1 and 2 in Section IV and will be discussed as subheadings under trouble No. 2.

(*1*) *Loose End Connections and* (*2*) *Open Circuits in Armature Coils.*—An open circuit in an armature coil produces vicious sparking when the commutator bars connecting the ends of the coil pass under a brush. In a machine operating at over 900 revolutions per minute the sparking will appear continuous. The mica will nearly always be found badly pitted between the bars connecting the ends of the defective coils. The trouble can be temporarily repaired by soldering the end connections or commutator risers together. In a lap-wound machine the defective coil can be readily located by the pitted mica between the commutator bars. In a wave-wound machine, however, the pitting occurs at two points and if the open connection is bridged over, great care should be taken to avoid short-circuiting a good coil.

A poor connection between the end of a coil and the commutator riser will produce the same sparking at the brushes and pitting of the mica but in a less degree, depending on how defective the contact is. When located, the defective connection should be carefully cleaned and resoldered.

2a. Short Circuit in Armature Coils.—A short circuit in a coil, a short circuit between two coils, or a ground between a coil and the armature core will result in excessive heating of that portion of the armature. A ground between a commutator bar and the clamping rings will result in excessive heating of that part of the commutator as well as the portion of the armature connected to the grounded commutator bars. Usually these troubles will be accompanied by poor commutation.

The diagrams shown as Figs. 1 and 2 illustrate the means of locating open circuits, high-resistance end connections, short circuits and grounds. Fig. 1 illustrates a lap-wound armature. Current from a battery should be passed through the armature by brushes *B B* and a bar-to-bar test made with a telephone receiver, as shown at *A*. If the armature is in good condition, the click in the receiver will be the same between each pair of bars. If the click between any pair is less than

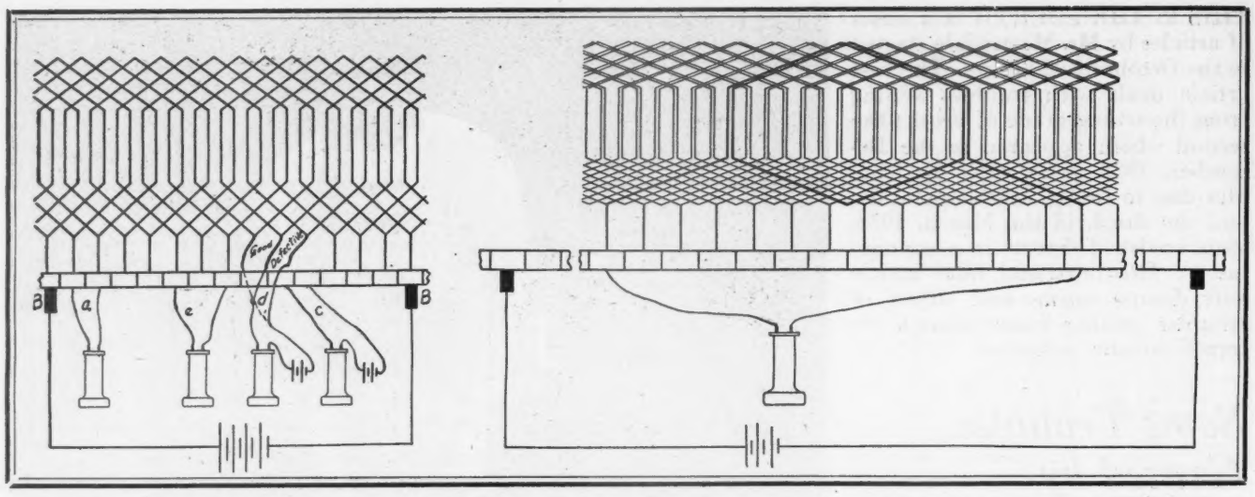


Fig. 1—Scheme for testing for coil troubles on a lap-wound armature.

Fig. 2—Scheme for testing for coil troubles on a wave-wound armature with two turns per coil.

normal there is a short circuit between two or more turns of the coil or between the commutator bars or risers. Examine carefully the commutator-bar risers to see that they do not touch each other or that no conducting material has gathered between them, and if they are found clear the end connections of the defective coil should be unsoldered and a test made between the commutator bars, as shown at *C*, with the battery in series with the telephone receiver. If a click is heard the short circuit is in the commutator, while if none is heard it is in the coil. On the bar-to-bar test if the click between any pair of bars is greater than normal there is an open circuit or a high-resistance connection. To determine whether trouble lies in the coil or the end connections, the latter should be unsoldered on the defective coil and on a good coil for comparison. The telephone test should be made as shown at *D* in Fig. 1. If the click is the same in the opened coils, the trouble is in the end connection. If no click at all is heard in the defective coil, or if the click is weaker in the defective coil than in the good coil, the trouble is in the coil and it must be replaced.

The number of coils per slot is equal to the number of commutator bars divided by the number of armature slots. If all individual coils are found correct and if there is more than one coil per slot, the first test should be repeated, spanning an extra commutator bar as shown at *E* in Fig. 1. This will locate any short circuits between two coils in the same slot as the click will be less when bridging the short.

In Fig. 2 a wave-wound armature is shown. Current should be passed through the armature as in the previous tests. Blue prints should be obtained from the manufacturer or the windings traced to determine the number of bars between adjacent brush studs of the same polarity and to determine whether the winding is progressive or retrogressive. In the usual "simplex" wave windings the number of bars will be found to be one more or less than an even multiple of the number of poles. If the number is one more the winding is progressive, and if one less it is retrogressive. In a progressive winding if we trace the connection once around the armature we arrive at the commutator bar ahead of the one from which we started. In a retrogressive winding we arrive at the bar behind the one from which we started. There are also some wave-wound machines where tracing once around the armature will bring us

Fig. 3—A milli-voltmeter provides another method of testing an armature for short circuits between coils.

to two bars ahead or behind the starting point. This is called a duplex winding.

In Fig. 2 is shown the method of locating short circuits, open circuits and high-resistance connections in a wave-wound armature.

Current should be passed through the armature from a small battery at one positive and one negative brush on the opposite side of the commutator from where the tests are being conducted, all other brushes being removed.

The terminals of the telephone receiver should touch the bars connected to the opposite ends of the coil as shown in Fig. 2. After the proper spacing has been determined a string may be tied between the two terminals to keep the spacing correct. The test should be conducted clear around the armature. As in Fig. 1 a loud click will denote a high-resistance connection or an open circuit. If there is an open circuit, it is probable that no click will be heard until the telephone receiver bridges the defective coil. As in *D*, Fig. 1, the coil should be opened to determine whether the trouble is in the coil or in the end connections.

If the click is less at any point there is a short circuit in the coil. The test for a short circuit between two coils in a wave winding will depend on the nature of the winding. If it is a "simplex progressive" the spacing between terminals should be one less than in the above test. If it is a "simplex retrogressive" the spacing should be one more. If it is a "duplex progressive" the spacing should be two less bars, and if "duplex retrogressive" it should be two more bars. A click less than normal will locate the short.

To test for short circuits between commutator bars, the bar-to-bar test should be used as in Fig. 1.

2b. Grounded Armature Coils or Commutator Bars.—To test for a ground, all brushes should be removed. The telephone receiver should be connected from the armature shaft to the commutator bars with the battery in series.

Usually a grounded armature will cause excessive heating of both the commutator and the armature coils connected to the defective bar. After the ground has been approximately located the nearby end connections should be unsoldered and the test repeated to determine whether the ground is in the commutator or in a coil and, if the latter, in which coil.

Fig. 4—Handling armatures in a sling made from belting lessens the chances of burring laminations. Jamming the edges of laminations so that they make electrical contact with each other promotes the flow of eddy currents and may be the unexpected source of heating.

If the armature is wave-wound and the commutator bars are free from grounds, care should be taken to unsolder the connection at both ends of the coils before trying to locate the exact coil.

3. Unbalanced Armature Winding.—By an unbalanced armature winding is meant one which does not have a theoretically perfect layout of coils or end connections. Practical details of such windings and the points to be considered were given by A. C. Roe under the heading "Laying Out Unequal Groupings of Coils" in the May, 1923, issue of INDUSTRIAL ENGINEER, pages 241 to 250.

4. Mechanically Unbalanced Armature.—If an armature is mechanically unbalanced it will set up vibrations when operating at full speed. On high-speed machines the vibration may be sufficient to throw the brushes from the commutator, resulting in sparking and flat spots and may even chip or break the brushes. The armature should be placed on parallel bars or balancing ways and sufficient weight added at the lightest point to balance it properly.

5. Jammed Armature Laminations.—Very little has been written on this important subject and it is doubtful whether its seriousness is generally appreciated. Armature cores are made up of a large number of thin iron stampings called laminations. The object of this construction is to produce a relatively high resistance in the iron core to prevent heavy eddy currents caused by the transformer action of the current in the coils which reverse direction at every pole.

Rolling the armature across the floor or other rough handling may jam the edges of the laminations and make the armature almost like solid iron. Similarly, turning an armature in a lathe will usually burr the iron enough to run the laminations together. The writer knows of one case where an armature burned out by grounding every two or three weeks and the reason could not be located. Finally the armature winder remarked that it was always the same coil. Extra care was taken in insulating this coil, but the trouble occurred again with the same regularity. The chief electrician then dismantled the armature, removed all the laminations, filed the burrs from the edges, re-assembled the armature and the motor ran for two years without another burn-out.

Another chief electrician of a large plant considered the care of armatures so important that he called all of his men in to watch him burr over the edges of the laminations along just one armature tooth with a light ball hammer.

Then he passed alternating current through the armature equal to full load current and in less than an hour that tooth was a dull red and had charred the insulation on the adjacent coils.

If you have repeated burn-outs mark the armature so that you can determine whether it is always the same coil and, if so, it is probably caused by burred laminations. An armature should be handled with as much care as a watch.

6. Partial Short in Shunt Field.—If the shunt fields are in parallel, a partial short in one field will produce excessive heating of that coil, but if the fields are in series, as is usually the case, the partially shorted coil will be somewhat cooler than the others. If they are in parallel the trouble may be detected with an ammeter as the current will be higher through the defective coil. If they are in series the trouble may be detected with a voltmeter by reading the voltage drop across each coil. The voltage will be less across the defective coil. The result of a partial short in a shunt field is to reduce the strength of that field causing an unequal generation of voltage in the armature and a shifting of the neutral point which will usually cause sparking with all its attendant evils.

7. Series Field Poorly Adjusted.—In this article we are referring to the series field of compound machines and not to the straight, series-field motor. Series fields are used to change the field strength in accordance with the load on the machine. In a few cases the series field is made to oppose the shunt field in order to maintain constant speed at all loads and is called the differential-compound winding. In the great majority of cases the series field is

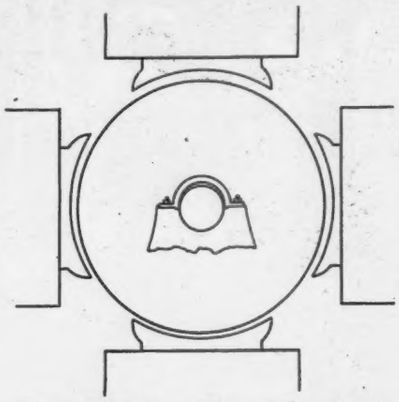


Fig. 5—Section of four-pole motor showing unequal air gaps due to worn bearings.

used to assist the shunt field. In a generator it is used to maintain constant voltage or in some cases the field is over-compounded in order to increase the voltage with increased load to compensate for line drop and thereby maintain constant voltage at the load.

In a motor this compounding enables it to carry a greater load and also helps to counteract the armature reactions and prevent the shifting of the neutral point too far for good commutation.

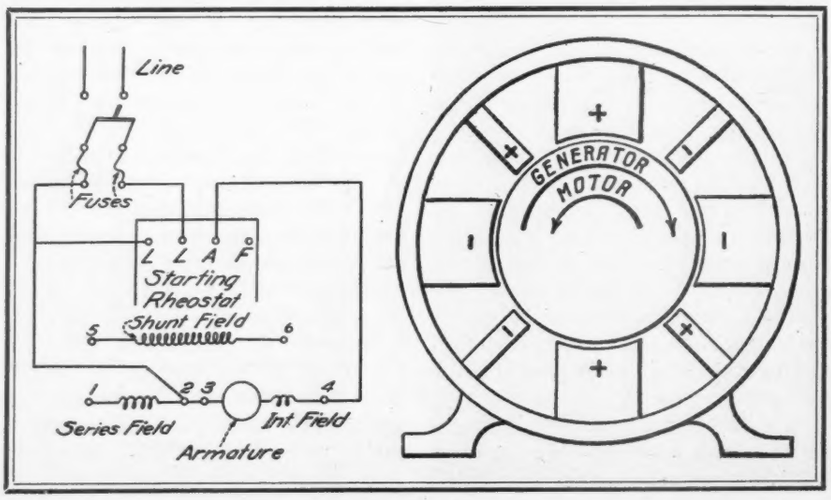
Some series fields have shunt adjustments to regulate the current through the series field and if these are not evenly and properly adjusted or if the series field is not correctly designed, it may result in poor commutation at certain loads, with armature heating due to the short-circuit current under the brushes.

8. Series Field Bucking.—By this we mean one or more of the series field coils opposing the shunt field when they should be assisting. This error is easily made when re-assembling the fields as it may be done either by putting one coil upside down or simply by getting the terminals reversed when connecting the coils together.

No difference in operation may be noticed with light loads, but with heavy loads the series field weakens the shunt field to such an extent that the pole face is no longer saturated with magnetic flux and the armature reactions overpower the field flux enough to reduce the magnetic flux below the saturation point, which permits of a serious distortion of the field and a shifting of the neutral point. This will throw the coils undergoing commutation in a strong field which will cause heavy short-circuit currents under the brushes, accompanied by severe sparking.

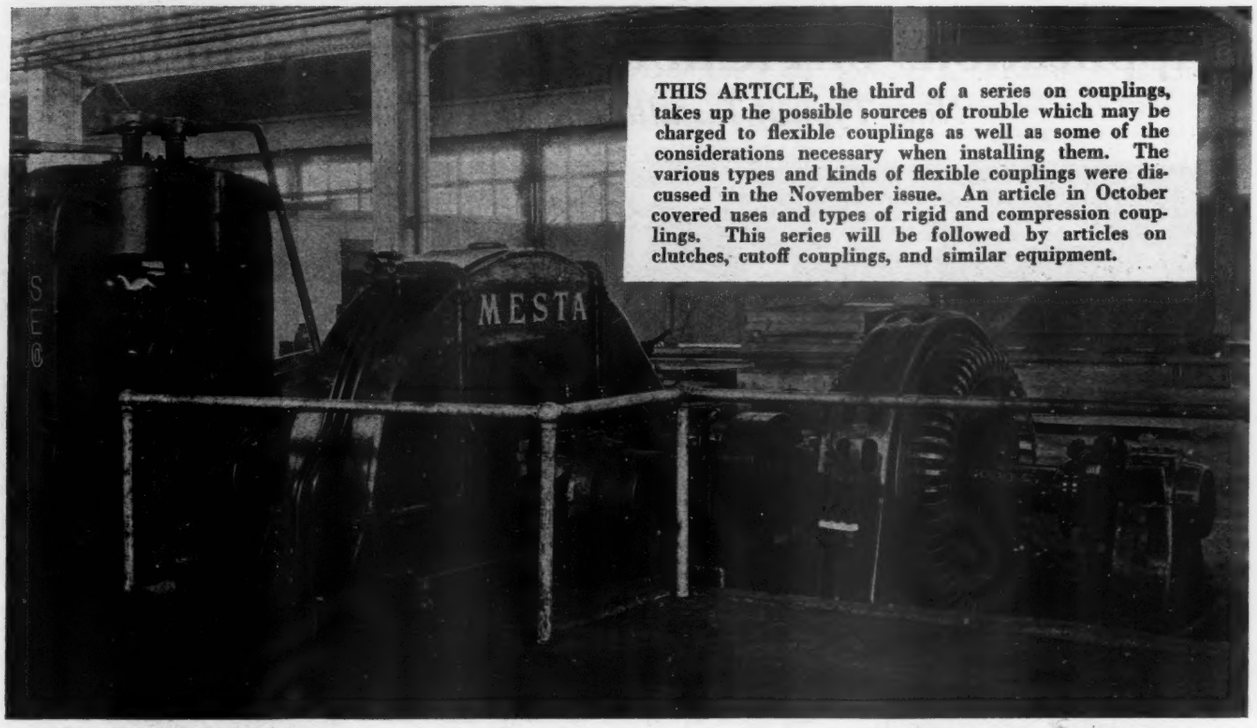
To test for a bucking series field pass current through the shunt fields and by means of a compass mark each field "*N*" or "*S*" depending on which end of the needle is attracted by the pole piece. Next disconnect the current from the shunt field and pass through the series fields taking care to see that the current flows in the same direction as when the machine is in operation. This must be done through some resistance or other means of limiting the current on account of the low resistance of the series winding. It is well to have the test current at least 10 per cent of the full load current to avoid the possibility of residual magnetism in the pole pieces proving stronger than the weak series field. Now repeat the compass test making sure that each pole piece attracts the same end of the needle as in the former test. If any pole piece shows a different polarity that series field is reversed and the leads must be interchanged or the coils turned around. In making this test, care should be taken to bring the compass to the pole piece slowly at the same time watching to see that the needle bearing is free as it is very easy to reverse the magnetism in the average compass needle.

Fig. 6—Polarity of interpole fields for directions of rotation of motors and generators and connections for testing correct connections of interpole windings.



9. Poor Adjustment of Interpoles.—The object of an interpole winding is to produce sufficient flux to offset the armature reactions and maintain a constant field which will produce an approximately constant voltage in a generator or constant speed in a motor.

If sparking or change of speed in a motor, (*Continued on page 612*)



THIS ARTICLE, the third of a series on couplings, takes up the possible sources of trouble which may be charged to flexible couplings as well as some of the considerations necessary when installing them. The various types and kinds of flexible couplings were discussed in the November issue. An article in October covered uses and types of rigid and compression couplings. This series will be followed by articles on clutches, cutoff couplings, and similar equipment.

Here a 300-hp., 2,200-volt, 60-cycle, three-phase, 300-r.p.m., mill-type, slip-ring induction motor drives a 26-in. cold mill for the International Nickel Company through a bushed pin type of flexible coupling.

How Troubles Charged to

Installation and Operation of Flexible Couplings

Can be Eliminated with Suggestions for Choosing Couplings of the Proper Size

By FRANK E. GOODING
Associate Editor, Industrial Engineer

FLEXIBLE COUPLINGS act as safety links by preventing damage to more expensive equipment from excessive wear, shocks and strains through carrying the brunt of carelessness in installation or operation. Just as electrical trouble has been blamed sometimes on the electrical safety link—the fuse—when it blows, so have flexible couplings been held responsible for some mechanical difficulties due to excessive wear. The remedy is to find and remove the cause, which is generally outside the safety link, instead of merely renewing the fuse or coupling or installing one of larger size.

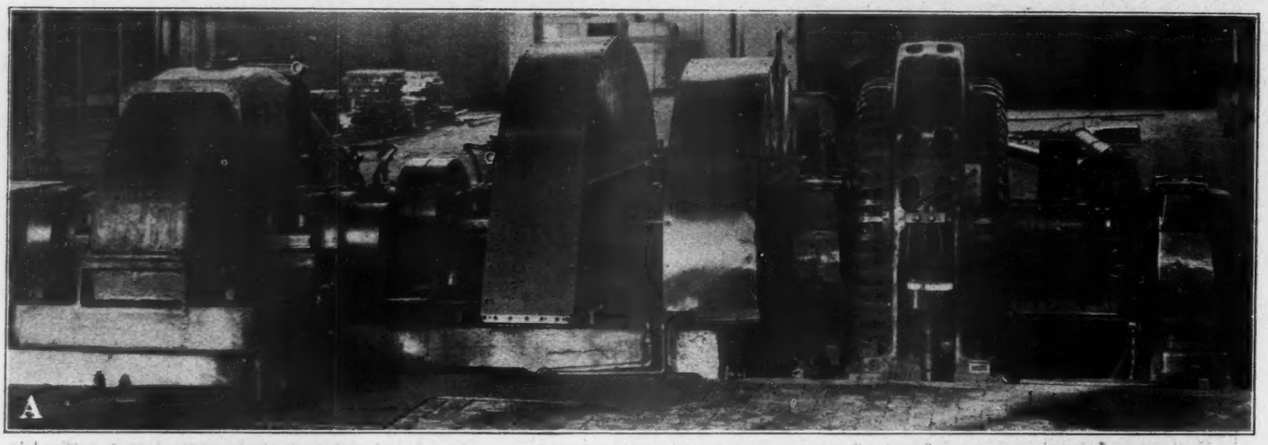
FLEXIBLE COUPLINGS, as was pointed out in the article in the November issue, which discussed some of the various types and kinds of flexible couplings and their applications, are not intended to take the place of carefulness in installation and a frequent checkup and correction of misalignment. Where trouble is found in the operation of a flexible coupling it can usually be traced to careless or improper installation, neglect after installation, or to a selection of a size or type not suitable for that particular purpose. In this way a flexible coupling is no different from any other piece of equipment as these same three reasons may be attributed as the cause of a large percentage of all trouble with mechanical or electrical equipment.

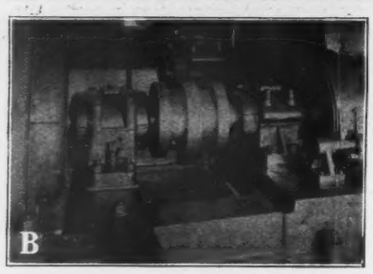
The purpose of flexible couplings is to protect the connected shafts, bearings, gears and the machine itself against destructive misalignment strains. In this way they are comparable to an electric fuse which operates as a safety device in case of overload. A fuse, however, fails when the overload comes on and so protects the equipment by opening the circuit. A flexible coupling, instead, is made almost as strong and frequently stronger than the shaft and so cannot fail in the same way. However, the coupling provides a cushioning effect to smooth out shocks and vibrations and to care for misalignments and in addition serves as a mechanical fuse by bearing the brunt of the wear.

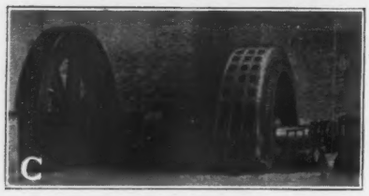
If shafts are properly aligned and frequently checked to see that reasonable alignment is maintained there should be little difficulty in the operation of the flexible coupling, unless the wrong coupling is used or it is neglected. Where it is difficult to keep the shafts in reasonable alignment, something else than the coupling is at fault. The coupling, however, shows the effect of this misalignment and is the safety link which takes the wear. Because it

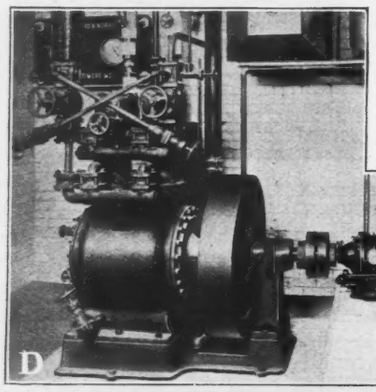
Applications of Flexible Couplings in Industry

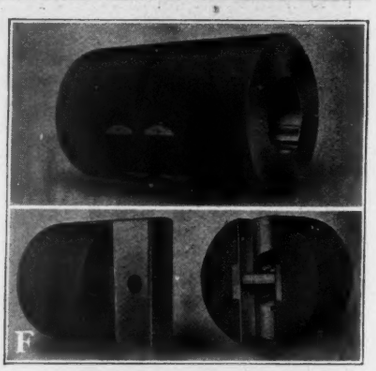
Nine Typical Installations of Various Sizes











A—A 500-hp., 2,200-volt, 60-cycle, three-phase, 450-r.p.m. mill-type, slip-ring induction motor driving a 14-in. Belgian rougher.

B—A close-up of another type of flexible coupling operating between an 850-hp. motor and a mine hoist.

C—A bushed-pin flexible coupling between the 2,000-hp., 83 1/3-r.p.m., 25-cycle, 6,600-volt rolling mill induction motor and the flywheel on a plate mill.

D—Here one coupling operates between the 15-hp. motor at 775 r.p.m. and a reduction gear and another flexible coupling between the reduction gear and an ammonia compressor, running at 155 r.p.m.

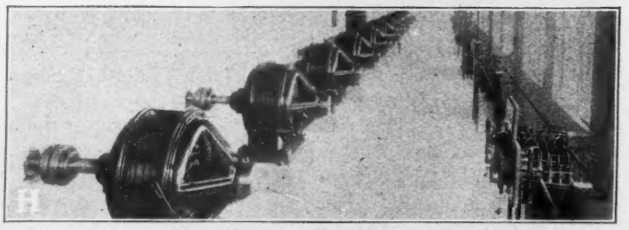
E—A flexible coupling connects the 60-hp., 345-r.p.m. motor to an induced-draft fan.

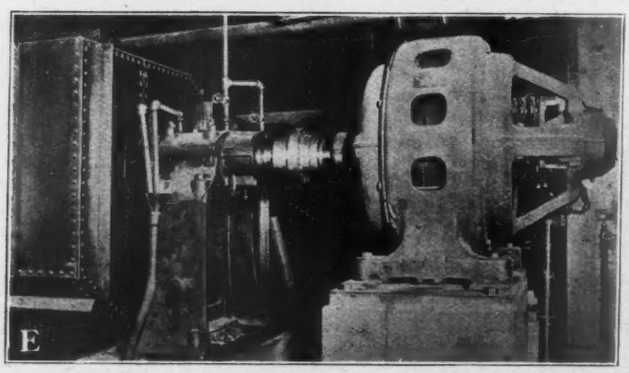
F—Two views of a universal joint type of flexible coupling sometimes used on heavy-load and low-speed work.

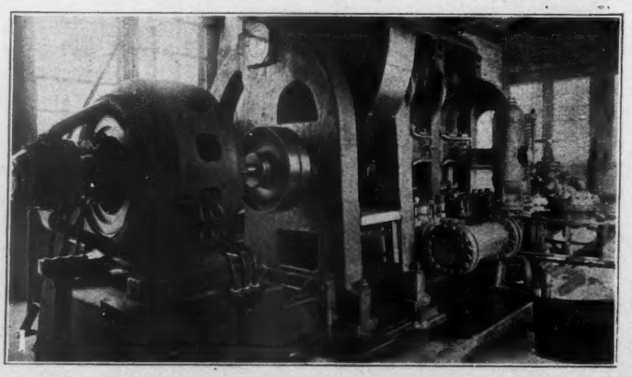
G—Here the 74-hp. motor operates at 1,450 r.p.m. and is connected to a forced-draft fan.

H—A battery of motors is connected by flexible couplings to triplex power pumps for oil pipe line service.

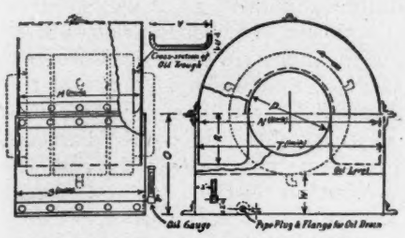
I—This 150-hp. induction motor is connected through a coupling and herringbone gear to a triplex pump.







does wear it is frequently blamed for causing trouble, just as the fuse is sometimes blamed when it blows. In such cases the manufacturer of



One type of oil housing for lubricating flexible couplings.

a coupling, through his wide experience with miscellaneous operating conditions, can usually recommend a method of overcoming as well as for locating the difficulty if he knows the full operating conditions. It should always be kept in mind that where difficulty is experienced in maintaining alignment the installation cannot be neglected and deliberately permitted to run badly out of line and still give satisfaction.

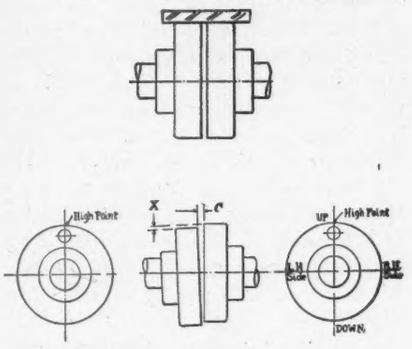
Reasonable care when initially lining up shafts increases the capacity of the coupling to take care of subsequent operating misalignment. How this alignment may be checked up is described later in this article.

If the parts of a coupling show more wear than may reasonably be expected it may be due to any of the following causes: (*a*) Exposure to moisture, dirt, or grit, which may cause rusting or abrasion, (*b*) excessive endwise motion of one or both connected shafts, (*c*) excessive angular misalignment—shafts not parallel, (*d*) coupling too small, (*e*) lack of suitable lubrication. If the coupling is operated where there is likely to be moisture, grit, or dirt, the coupling should be enclosed in a canvas or leather boot or by a stationary sheet metal case, depending upon the speed of operation. Such operating conditions are somewhat unusual and it is best to refer them to the manufacturer for his recommendations. If the coupling is located in a wet or gritty place and does not operate at a peripheral speed greater than 2,500 ft. per min., the space between the flanges may be filled with a medium cup grease and the whole enclosed in a canvas or leather bag wired securely to both halves. Another type of boot can be made by using a strip of single-ply leather belt as wide as the two flanges and lapping the ends. Metal oil cases, as shown in the sketch above, are recommended for high-speed work and may also be used on low-speed operation. Of course, lubrication cannot be used and is not necessary in connection with couplings which depend for their flexibility on rubber, fiber or leather pads or bushings.

In case either or both machines "plunge" or oscillate with respect to the other or to each other, the cause of the unnecessary wear may be removed by leveling up the machines and by using proper locating collars on the connected shafts. For example, sometimes an electric motor has a "magnetic center" or operating point other than that where the rotor shaft operates halfway between the mechanical limit of the locating collars on that shaft. In such a case, by disconnecting the two halves of the flexible coupling and running the motor, the operator can determine the point at which the motor will operate and the spacing of the coupling should be changed accordingly by moving one flange on its shaft or by moving one machine endwise. Each type of flexible coupling indicates the proper amount of space which should be allowed between the flanges for the best operation.

If excessive angular misalignment is the cause of excessive wear, the machines should be leveled up and the shafts lined up. On some types of flexible couplings this angular misalignment can be found by checking the parallelism of the face of the flanges of the two couplings when disconnected by using a steel block and feeler or a steel wedge between the flanges at points diametrically opposite. These should be tested in at least four positions, approximately 90 deg. apart.

When a coupling is found to be too small it is usually the result of having neglected to take into account a maximum peak load. This may be due either to a momentary overload, an excessive r.p.m., to a change in the loading, or to failure to take into account the kind of machines connected as, for example, if a motor drives a reduction gear which in turn is connected to a compressor, the complete installation should be considered. If in addition a flywheel is connected in the lines, its location and effect should be considered in estimating the loading. Frequently after couplings are installed, machines are added or are required to handle material (this is particularly true of mixing and stirring machines) of a much heavier nature than was originally planned and so the load is increased. The solution is, of course, to obtain the proper size coupling. In some cases



These sketches show the method to be used in aligning the couplings and shafts when installed.

and with some types this is possible by a change in size of links or some of the other units within the coupling, so that a complete new coupling is not required.

Couplings operating at high speed and under continuous, 24 hour per day service, or under frequent and repeated reversals, usually require lubrication unless a resilient material is used which will not permit it. This lubrication may be obtained as previously explained. Some types of flexible couplings are so constructed as to retain the oil or grease within themselves and not require additional boots or covers.

A common cause of difficulty with some types of couplings, particularly those which have a flexible pin connection between the flanges, is either too much or too little spacing between the flanges. In either case the improper spacing causes excessive wear upon the pins and the units retaining the pins in position. The difficulty, of course, shows up in excessive wear of the coupling which, as previously stated, acts as a safety link or fuse in the unit. The proper procedure is, of course, to see that the correct spacing is obtained between the flanges. This may be done in some cases by moving the flanges; if this is not possible a machine must be shifted. In other cases the coupling may appear to pull the shafts together or push them apart. Usually the real cause of this will be found to be an unbalance of one of the connected machines, the machines are out of level, or there may be some internal or external pressure of one of the machines. If the flanges are disconnected or connected loosely and operated, it is sometimes found that under load the

flanges will open up or close more or less than the intended spacing. After the cause has been corrected the flanges should be connected up as intended.

When ordering parts for a coupling from the manufacturer, the serial number of the coupling, which is usually found stamped on the coupling flange, as well as any other information given there, should be included. From this serial number in nearly all cases the manufacturer can locate the particular size and type of coupling and also obtain from his records the bore and other dimensions included in the original order. The quantity required and shipping directions are also obviously necessary. It is well, in case of broken parts, if the user has not discovered the cause of the difficulty, to send some of the worn parts or at least completely describe the extent and location of the wear to the manufacturer, as his experience will usually help to locate the source of the trouble and also assist in its correction. It does little good to install new parts without correcting the condition which caused the excessive wear or breakage.

Some Suggestions on Alignment of Flexible Couplings

The exercise of due care to obtain good initial alignment of the shafts will provide greater capacity to the flexible coupling to take care of subsequent operating misalignments. Any specification of definite limits is difficult; the greater the speed, the greater the care desirable. Most turbine builders line up their machines initially within 0.002 in. to 0.004 in. On lower-speed, heavy-duty drives 0.01 in. is good practice, easily obtained without micrometer gages. Perhaps the best advice is to line up as carefully as possible with the tools available. Occasionally after operation the alignment should be checked and corrected if necessary.

Before lining up initially and whenever convenient in rechecking alignment, remove flexible pins (or coupling bolts). Also level up.

To line up a flexible coupling use a steel straight edge across both flanges in four positions at approximately 90 deg. intervals. Shim up the lower machine all around or move one machine sidewise, or both, so that the straight edge will lay flat across both flanges at all four positions. Next use a steel block and feeler (or a steel wedge) between flanges at four similar positions. Shim up one end of one machine or move this end sidewise, or both, pivoting around the coupling until these four spacings also are the same.

To obtain exact initial alignment and to correct for any possible eccentricity of the individual flanges, first find and mark with chalk the high points of the individual flanges by rotating them separately and then put the high points together. Insert one flexible pin (or a loosely-fitting through bolt) so that flanges may be turned over together by hand. When turning them over consistently crowd the flanges either apart or together. Take readings for both X and C, as shown in the sketch (page 581), between the same points as the two flanges at the four positions.

If C does not measure the same at all four positions, one machine should be pivoted around the coupling by shimming at one end or by sliding at that end, or both, until all the measurements are the same. If the measurements for X are not the same at all four positions then one machine should be shimmed up all around or should be moved sidewise, or both, until these four measurements also are the same.

In special cases or if flanges are of a dis-similar diameter, use a C clamp and offset arm with a pointed setscrew. With a feeler obtain measurements for X as above between point of setscrew and periphery of flange. Scribe a line on this flange and obtain measurements from point of setscrew to this line, as for C above. In both cases revolve flanges together, crowd them apart or together, and correct for the misalignment as above.

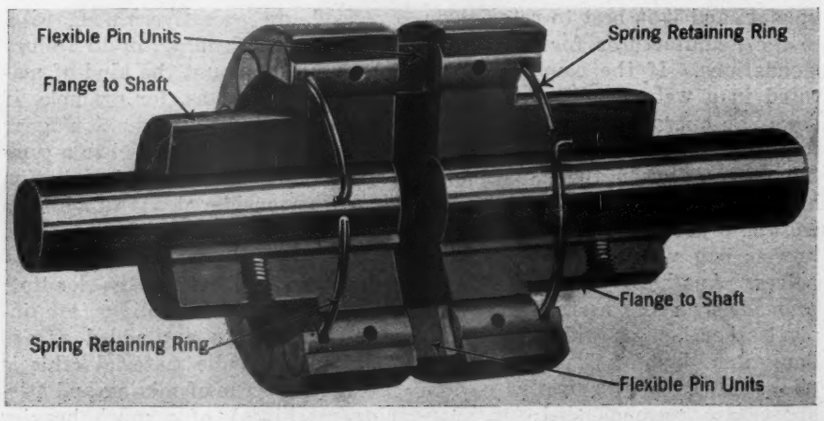
A turned or ground bar for a sliding fit in the pin holes will serve instead of a straight edge across the flanges. This will also test for concentricity of pin circle diameter with respect to bores or flanges.

After all readings for both C and X have been finally checked as correct, set up bolts and dowel machines in place. If a machine is to be redoweled after correcting for misalignment, do not use the same dowels and holes, but drill and ream new holes, or ream out the old holes and use larger dowels.

Points to Consider When Specifying Flexible Couplings

When ordering a rigid or compression coupling for a lineshaft drive as was mentioned in the article in October, it is only necessary to give the diameter of the shaft, as these couplings are designed and in a measure standardized to transmit the rated horsepower of the shaft. The critical point, then, is in the selection of the proper size of lineshaft, which will not be considered in this article.

Flexible couplings should be selected in an entirely different way. Because manufacturers of motors, turbines, mills and other machinery frequently are called upon to design a shaft to sustain a heavy bending load, as of a mill or the rotor of a motor, generator or turbine, in addition to the twisting or torsional load due to power transmitted it is absolutely necessary to make, in many instances, much larger shafts than the horsepower or rating alone would call for. To meet this, practically all flexible coupling manufacturers have standardized their



A phantom view of one type of flexible coupling.

Here the flexible units are made up of laminated pins of spring steel fastened together at each end and held in position so that they do not turn by the steel retaining rings. If it should be necessary to remove one of these flexible steel pins, it is only necessary to slip out these spring retaining rings and insert a new pin.

Rating Factors for Determining Size of Flexible Coupling for Various Loads and Drives

Kind of Apparatus	Factor*
Steam-turbine centrifugal pumps, blowers or other smooth load	1¼
Turbo-generators, motor-generators	1½
Motor-driven centrifugal pumps, blowers or other smooth load	1½
Motor-driven woodworking machinery, shafting	2
Motor-driven conveyors, screens, beaters, with no pulsation	2
Motor-driven four-stroke (duplex, double-acting) pumps	3½
Motor-driven triplex (single-acting) pumps	3½
Gas engine triplex (single-acting) pumps	5 to 6
Motor-driven crushers, tube mills, hogs, pulverizers	4
Motor-driven rolling mills, steel, rubber or brass	4
Motor-driven mine hoists, elevators, cranes, screw downs	4
Gas or steam engines with flywheel, to smooth load	3 to 5
Motor-driven compressors	6
Engine-driven fans, engine mine fans	8

*Note.—Multiply the horsepower transmitted per 100 r. p. m. by the factor given in the above table; this gives the actual service load on the coupling.

method of rating couplings to a definite horsepower per 100 r.p.m., and a maximum possible bore. That is, the first consideration is the power requirements and the second consideration is the bore. Some manufacturers are rating their couplings and calling them by the size number corresponding to the rating to emphasize this point.

For example, suppose a flexible coupling is desired for a 50-hp. motor operating at 1,200 r.p.m. with the largest shaft 2⅝-in. diameter. The first step is to reduce the motor rating to terms of hp. per 100 r.p.m. To do this divide the horsepower by the r.p.m. and multiply by 100. In this instance, the rated load will be 4⅙ hp. per 100 r.p.m. The second step is to multiply this rated loading by the service factor for the particular duty as recommended by the coupling manufacturer. This is *important*. The result is the required coupling hp. per 100 r.p.m. and it should be compared with the manufacturer's rating. For example, for a motor-driven centrifugal pump where the motor may have overload rating of 50 per cent, a service factor of 1½ might be recommended. In such a case a coupling rating of 4⅙×1½, or 6¼ should be used. However, if this motor is to be connected to an elevator load where the motor has 100 per cent overload capacity and where the service is intermittent or subject to frequent reversal, then a service factor of four (4) might be recommended. In this case the coupling rating required would be 4⅙×4, or 16⅔ and a larger coupling having more power capacity should be used.

After a coupling has been selected with sufficient power capacity it should, of course, be determined whether it has sufficient capacity for the largest shaft and sometimes the largest shaft may require a coupling having more power capacity than is needed for the load alone.

Consulting one manufacturer's table (this would vary according to the different types and makes of flexible couplings) one size has a maximum bore of 2⅝ in. which is satisfactory, and a horsepower rating of 9 per 100 r.p.m. However, as this is lower than required (16⅔), the next size, which has a maximum horsepower rating of 28 and a maximum bore of 3 in., must be selected. The maximum recommended speed for this size is 1,900 r.p.m., which is well over the actual speed.

It is important to give the manufacturer the following information concerning any installations when ordering a flexible coupling as his recommendations, based on experience, are very desirable: (1) Normal horsepower rating; (2) normal r.p.m.; (3) kinds of machines (both driver and driven) and operating service; (4) dimensions of both bores and keyway sizes required.

Occasionally special operating conditions will prevail and it may be well to add the following service information: (5) Maximum overload; (6) is service reversing or non-reversing? (7) variable or constant speed; (8) is a flywheel used and where is it located? (9) what is the available space to accommodate couplings?

Some of the other factors to be considered when ordering flexible couplings are that occasionally care must be taken to see that the coupling is not so large in diameter as to have a flywheel action. This is particularly necessary in reversing drives. Other factors are end-thrust and back-lash in the gearing of the machinery driven, particularly when reversing.

Lubrication is an important operating condition in certain types of flexible couplings, particularly those in which metal parts are in flexure or slide on each other. The manufacturer usually provides some means of lubrication and specifies the type of lubricant to use. Lubrication, where necessary, cannot be neglected without causing trouble and flexible couplings are no exception.

In summarizing it may be well to again emphasize the three most important points to consider in the installation and operation of flexible couplings. In the first place a flexible coupling is *not* intended to take the place (*Continued on page 590*)

Another well-known coupling is here used in steel mill work.

In this installation a flexible coupling connects a 100-hp., mill-type reversing motor driving a blooming mill table. The motor operates at 580 r.p.m. but the coupling is connected to reducing gears which drive the rolls.

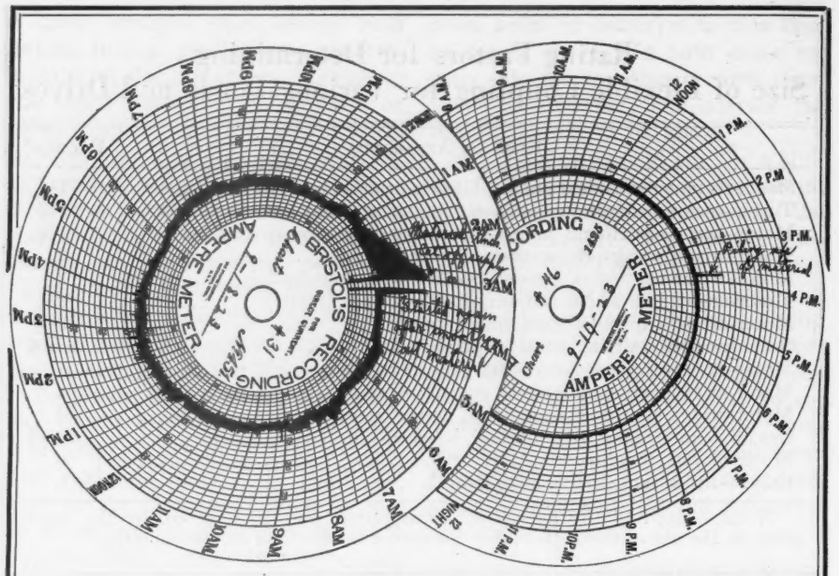
Here Is a Case Where a

Graphic Meter as a Watch Dog

For Overloads and Abnormal Service Conditions Prevents Breakdowns and Costly Repairs

By J. ELMER HOUSLEY

Electrical Engineer, Aluminum Ore Company, East St. Louis, Ill.



These graphic charts showed overloads that were removed before damage was done. When the overloads reached the danger point the operators stopped the machine and lightened the load. Note the smoothness of the alternating current curve shown at the right, while the direct-current chart at the left shows practically every load fluctuation.

THERE ARE many motor-driven process machines whose loads fluctuate widely and will at times overload the machine or the motor if they are not closely watched. About the only way of keeping a check on some of these machines is by using an electric meter, a graphic ammeter being particularly applicable to such work. The use of a graphic meter will prevent serious breakdowns which involve heavy repair bills as well as costly production losses. It may also detect other faults in the operation of the machine, such as running below capacity, irregularity of feed, and so on.

As an example of the benefits that may come from employing a graphic meter, it may be well to mention the case of four stirring machines in the Aluminum Ore Company's plant. Before installing the meters, one of these machines was out of service on an average of once every two months on account of overload which damaged the stirring device. A breakdown of this kind cost about $500 for repairs and a 25 per cent production loss. Since installing the meter we have experienced no breakdowns of this nature.

In "preventive" maintenance as affecting both the electrical and mechanical equipment, the chart of a graphic meter furnishes an invaluable record from the standpoints of both the engineer and the production superintendent. The engineer is interested in the time the drive is in operation over a given period showing the operating ratio which may be compared with an arbitrary normal. The lengths of interruptions are recorded and may be properly charged against the causes of the interruptions, whether from mechanical or electrical trouble and if originating through negligence of the operating staff.

The operating superintendent should be interested in the ammeter chart since it will indicate whether or not he is securing maximum output from a given machine. Furthermore the quality of the product is sometimes visually indicated by the varying line on the chart. In mixing operations involving arms and paddles in contact with materials which may vary in consistency, it is up to the man operating the machine to see that conditions do not arise which would throw such a load on the machine that it would wreck the stirring or agitating devices or burn out a motor.

The graphic record which goes on through the long watches of the night keeps the operators on the alert as they know they have a guide to follow constantly and any lapses in their vigilance will go on record against them. Often an investigation will indicate that the majority of preventable accidents to production machinery occur at night. The best method to reduce the number of such accidents is to secure some graphic record of the conditions surrounding past occurrences. Negligence cannot, of course, be eliminated by meters but responsibility put on the individual employe will often produce results impossible by other agencies.

Where the mixing devices may be raised or lowered or where the speed of the drive may be varied, the use of the recording meter permits close regulation of the mixing process. Where the drive is an agitator, quite often the consistency of the batch should be *(Continued on page 611)*

Mr. Housley points out that:

Before installing these meters certain machines were out of service on an average of once every two months. The repair cost was about $500 with 25 per cent loss in production. No breakdowns have occurred since the graphic meter was installed. Investigations have indicated that the majority of preventable accidents occur at night. Graphic records of conditions surrounding these occurrences help to provide the means to prevent them. Besides, the graphic meter can be used to check the performance of equipment from various locations where work may require the presence of the operator.

Diagrams and Information on

Two-and Four-Speed Windings

With Connections for Salient and Consequent Poles and the Possible Changes Outside the Motor

By A. C. ROE

Repair Superintendent, Detroit Service Department, Westinghouse Electric & Manufacturing Company

The slots in this motor, which is being wound for four speeds, are made extra deep to take a double winding.

SOMETIMES an induction motor is wound to give two speeds or four speeds, with the changes in speed effected by making various connections outside of the motor. Two different speeds may be obtained from one winding arranged to give two different numbers of poles. Usually the higher speed is obtained by the ordinary type of connections giving a certain number of salient poles. The lower speed is obtained by connecting the winding for twice as many poles, which are in this case "consequent" poles. These are explained in a later paragraph.

The four-speed winding is a combination of two of the two-speed windings placed in the same stator. Usually the two windings are located in the same slots, which are made extra deep especially for this purpose. A stator with slots of this kind is shown in the photograph at the beginning of this article. The two, two-speed windings, for instance, may give respectively four and eight poles, and six and twelve poles. A winding of this kind is described in what follows.

Difference Between Salient and Consequent Poles

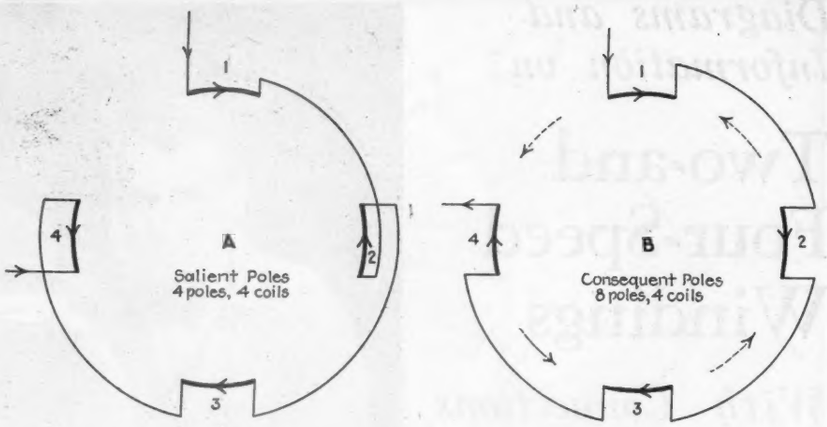
The ordinary type of winding for induction motors is connected to give what are called salient poles. With a salient-pole connection there is one magnetizing group of coils per pole (for each phase). In other words there are as many poles as there are groups. With the consequent-pole arrangement one group of coils forms two magnetic poles and, therefore, there are twice as many poles as there are groups of coils per phase. An inspection of Fig. 1 and Fig. 2 will help in understanding the arrangement of these two types of poles. In Fig. 1 is shown the frame of an ordinary direct-current motor. In *A* of Fig. 1 there are four field windings arranged, as they usually are on a direct-current motor, to give alternately north and south poles. This is the same connection of poles as that usually employed in an induction motor and the poles in this case are salient poles, each one being surrounded by a coil. The dotted lines indicate the path of the lines of magnetic force. The next drawing, *B*, in Fig. 1 shows the same motor frame, but in this case it has only two coils. As before, the first of these coils is connected to give a north pole and the second to give a south pole. A two-pole winding is the result, the magnetic flux following the dotted line shown in the drawing. These two poles are again salient poles, each one being surrounded by a coil.

Now if we reverse the polarity of the field coil on pole 3 the result will be four consequent poles. At poles 1 and 3 there will be two north poles and as there must be a return path for the magnetic flux, the lines of

AN INDUCTION MOTOR which will give two speeds has a winding only a little more complicated than the ordinary single-speed motor. In fact the only requirements which are not necessary in the single-speed motor are: (1) That "consequent" poles must be employed. (2) The coil pitch must be kept low. (3) A larger number of leads are brought to the outside of the motor. This article treats particularly these points. Salient and consequent poles are fully explained and their application shown. This brings in a discussion of the proper chord factor. Typical diagrams explain the connections of three different types of two-speed windings. When the two-speed motor is understood, the four-speed motor is easy because this is only a combination of two two-speed windings.

Fig. 2—Four salient poles or eight consequent poles from the same winding.

These are single-line diagrams showing four coil groups in each case, which represent one phase of a winding. In *A* these groups are connected top-to-top so as to give alternate polarities on alternate groups, resulting in four salient poles. In *B* the same groups have been connected for eight consequent poles by reversing groups 2 and 4. A motor connected as at *B* will run at half the speed of that at *A*.



force from poles 1 and 3 after meeting in the center of the air gap diverge to the right and left and enter poles 2 and 4. Thus poles 2 and 4 become south poles and there are altogether four consequent poles. To get the same magnetic density on the consequent poles as in the salient poles in *A* and *B*, the two coils in *C* must have twice the number of turns with the same current flowing as the coils in *A* and *B*.

Thus it is seen that we can change the two-pole winding at *B* into a four-pole winding, as at *C*, by reversing the polarity of one coil, which is the same as making all the field coils of the same polarity. This is the same principle that is applied in the case of two-speed windings for induction motors, the only difference being that the alternate *groups* of coils are changed instead of the single coils as shown in Fig. 1.

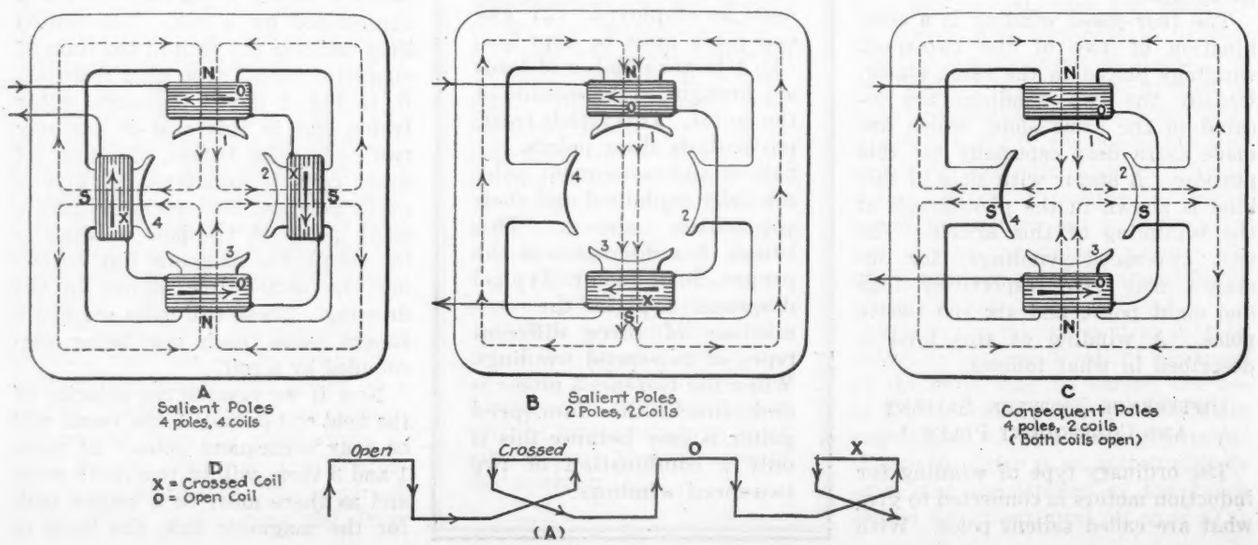
In Fig. 2 the principle which has just been explained is applied to a single-phase, four-pole, line diagram. At *A* of Fig. 2 four groups of coils are connected as in the ordinary manner, alternate groups having opposite polarity. The groups as connected in *A* give four poles which are in this case salient poles. To change the winding so that the same coils will give eight consequent poles the connections to groups 2 and 4 are reversed making these two groups of the same polarity as groups 1 and 3. This will form four poles of one polarity and cause four other poles of an opposite polarity to be formed between each pair of groups. This gives eight poles as shown in *B*.

In the motor shown in Fig. 1 there would, of course, be considerable leakage of magnetic flux particularly in diagrams *B* and *C*. For the sake of illustration, however, this leakage can be disregarded. In the case of induction-motor windings, although there is some leakage, it is not nearly so great as that in the machine shown in Fig. 1.

It may be well to explain here the terms "open" and "crossed" coils, which are mentioned in Fig. 1. In *A* of Fig. 1 there are two open coils and two crossed coils as shown in the small diagram at *D*. An open coil is one from which the starting and finishing leads are brought out straight, as shown in the first coil of the small diagram *D*. In a crossed coil the starting lead and the finishing lead are crossed and brought out on opposite sides as shown in the second coil of diagram *D*. In an induction motor an entire group of coils may be of the crossed type and this will permit of a short jumper between this group and the next adjacent to which it is connected, in case the groups are connected for salient poles as shown in *D*. The jumper is connected to the adjacent end of the crossed-coil group and does not have to pass across the coils to the further end of the group. In *B* of Fig. 1 the coils alternate open and

Fig. 1—The difference between salient and consequent poles.

At *A* and *B* are examples of salient poles, while at *C* there are four consequent poles. Drawing *A* shows the usual arrangement where four coils (or groups) form four salient poles. Drawing *B* shows two salient poles formed by two coils. The four consequent poles in drawing *C* are formed by reversing one of the coils in *B*. The result is two north poles at the coils and two south poles formed by the flux returning into the iron. The direct-current motor frames are shown in these drawings only for the sake of making the principles clear. These same principles hold for any type of winding used in induction motors. In the windings of modern induction motors, a group of coils replaces each coil in the diagrams shown here. The diagram at *D* shows the difference between an "open" coil and a "crossed" coil.



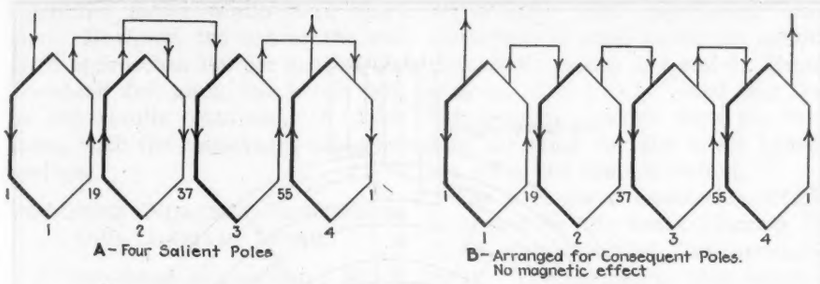


Fig. 3—A full-pitch, salient-pole winding cannot be reconnected for consequent poles.

The drawing at *A* represents a four-pole winding with seventy-two slots wound with full pitch. Each coil shown stands for a coil group. As may be seen from the arrows which show the direction of current flow, the currents in drawing *B* neutralize each other and the result is zero magnetizing current. If the pitch of the coils had been less than 1-and-19 there would be some magnetic flux set up in *B*. In practice the pitch should not be over 80 per cent of full pitch.

crossed as they do in all salient-pole connections. In *C*, however, all of the coils are open coils, giving consequent poles.

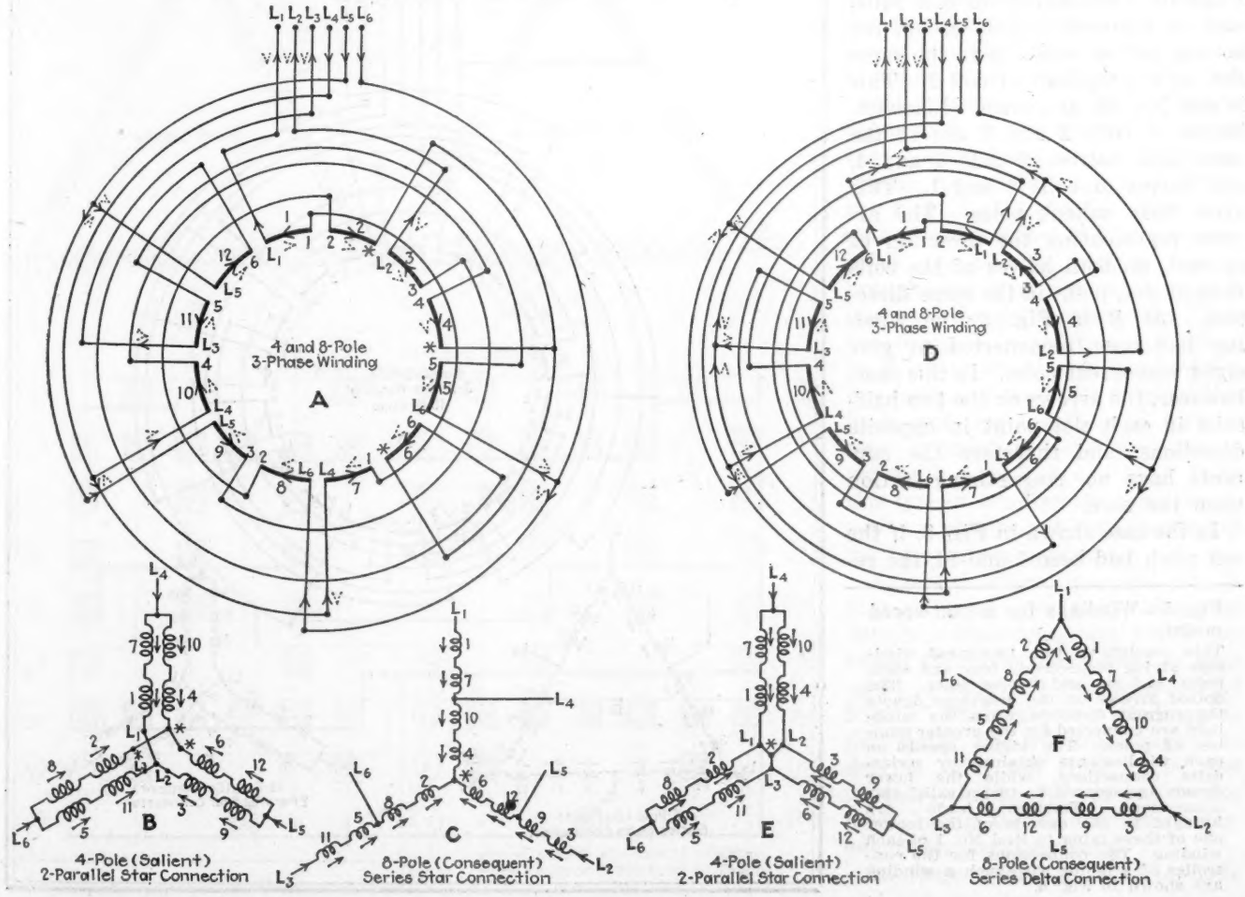
Grouping and Pitch Used With Two-Speed Windings

When an induction-motor winding is arranged for two-speed operation the coils are formed into groups of the same size as they would be for a winding which is to operate at the higher speed (lower number of poles). For example, suppose that a motor with seventy-two coils is to be arranged for four and eight poles in a three-phase connection. Then figuring on the higher speed or four poles, there would be $3 \times 4 = 12$ groups. Then $72 \div 12 = 6$ coils per group.

The coil pitch is usually made full pitch for the low-speed winding. In the case mentioned it would be full pitch for the eight-pole connection. As there are seventy-two coils, the pitch would be $72 \div 8 = 9$, which is a pitch of 1-and-10. This gives a chord factor of 100 per cent for the low-speed winding. With this coil throw the coil pitch for the high-speed winding is one-half full pitch. This gives a chord factor of 0.707. Of course these pitches may be varied for special conditions, but they serve very well for the two most common cases for which two-speed motors are employed. The first of these is the case in which the torque is to be kept practically the same at both speeds. The second condition arises when the horsepower is to be kept the same at both speeds. These two conditions can be met with fairly simple connections, using the

Fig. 4—Two examples of two-speed windings.

The winding at *A* gives the same torque at both speeds, while the winding at *D* gives the same horsepower at both speeds. These windings are both for four poles and eight poles. The dotted arrows in *A* and *D* show the direction of current for the eight-pole or low-speed connections, and the full arrows show the current direction for the high-speed connections. The small diagram *B* shows the four-pole connection for diagram *A*, which is a two-parallel star connection. The eight-pole connection is shown at *C*, which is a series-star connection. Six leads are brought outside the motor. The external connections of drawing *A* should be as follows: for four poles, line leads to L_4, L_5 and L_6; L_1 to L_2 to L_3. For eight poles the connections are: line leads to L_1, L_2 and L_3; L_4, L_5 and L_6 open. As shown at *E*, the four-pole connection of diagram *D* is two-parallel star, while the eight-pole connection is series-delta, as shown at *F*. The external connections for this winding are as follows: for four poles, line leads to L_4, L_5 and L_6; L_1 to L_2 to L_3. For eight poles the connections are: line leads to L_1, L_2 and L_3; L_4, L_5 and L_6 open.



coil pitches just mentioned. When calculating the horsepower, and so on, for windings arranged for two-speeds the different distribution factors of salient-pole connections and consequent-pole connections must, of course, be taken into account. Information on distribution factors for various kinds of connections was given in an article by A. M. Dudley, in the July issue of INDUSTRIAL ENGINEER.

The motor connected in the ordinary manner for salient poles can be reconnected for twice the number of consequent poles providing the coil pitch is not over 80 per cent of full pitch. Of course with any pitch which is below full pitch it is possible theoretically to get consequent poles, but with a pitch greater than 80 per cent of full pitch of the original winding the consequent-pole arrangement will give comparatively little power. When the coils are connected for full pitch on the original salient-pole winding, no power at all will be delivered if the same groups are reconnected for consequent poles. This fact is illustrated in Fig. 3. At *A* of Fig. 3, is shown a diagram representing a four-pole motor having seventy-two slots. Full pitch would be $72 \div 4 = 18$, or a pitch of 1-and-19. Then laying out four coils, each to represent a pole group, the bottom half of coil 1 is in the same slot as the top half of coil 2. This is slot No. 19, as shown. Likewise, halves of coils 2 and 3 are in the same slot, halves of coils 3 and 4, and halves of coils 4 and 1. This gives four salient poles. The arrows representing the direction of current, on both halves of the coils in each slot, point in the same direction. At *B* in Fig. 3, the winding has been reconnected to give eight consequent poles. In this case, however, the arrows on the two half-coils in each slot point in opposite directions, and therefore the currents have no magnetizing action upon the core.

In the case shown in Fig. 3, if the coil pitch had been 1-and-14, the re-

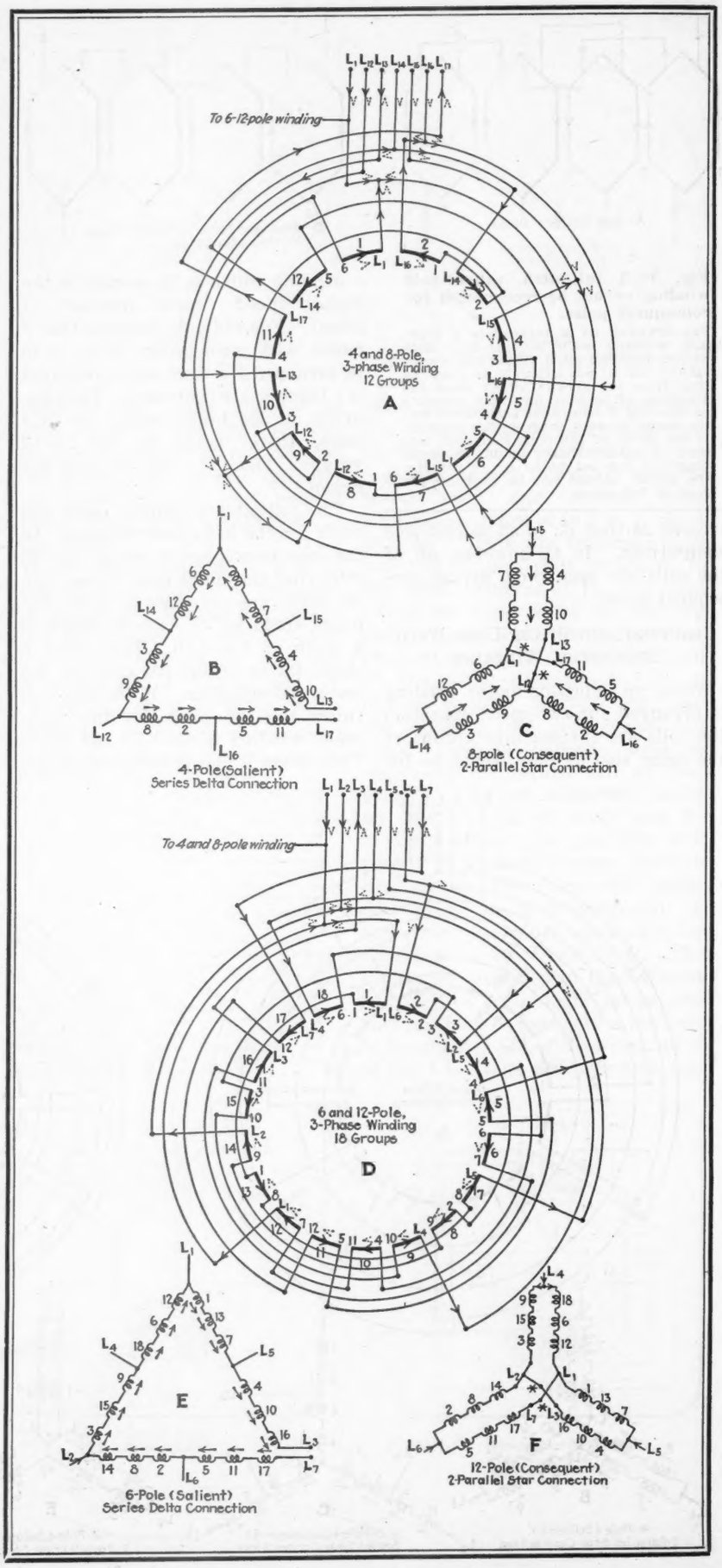


Fig. 5—Windings for a four-speed motor.

This consists of two, two-speed windings giving respectively four and eight poles, and six and twelve poles. The dotted arrows on the diagrams denote the current direction when the windings are connected for the greater number of poles. The higher speeds on each winding are obtained by series-delta connections, while the lower speeds are secured by two-parallel star connections. Thirteen leads are brought to the outside of the motor, one of these tying to lead No. 1 of each winding. The connections for the controller of a motor with such a winding are shown in Fig. 6.

connected motor would have operated. However, the nearer the coil pitch approaches 100 per cent of the low-speed full pitch, the better will be the results obtained, in most cases, with the consequent-pole connections.

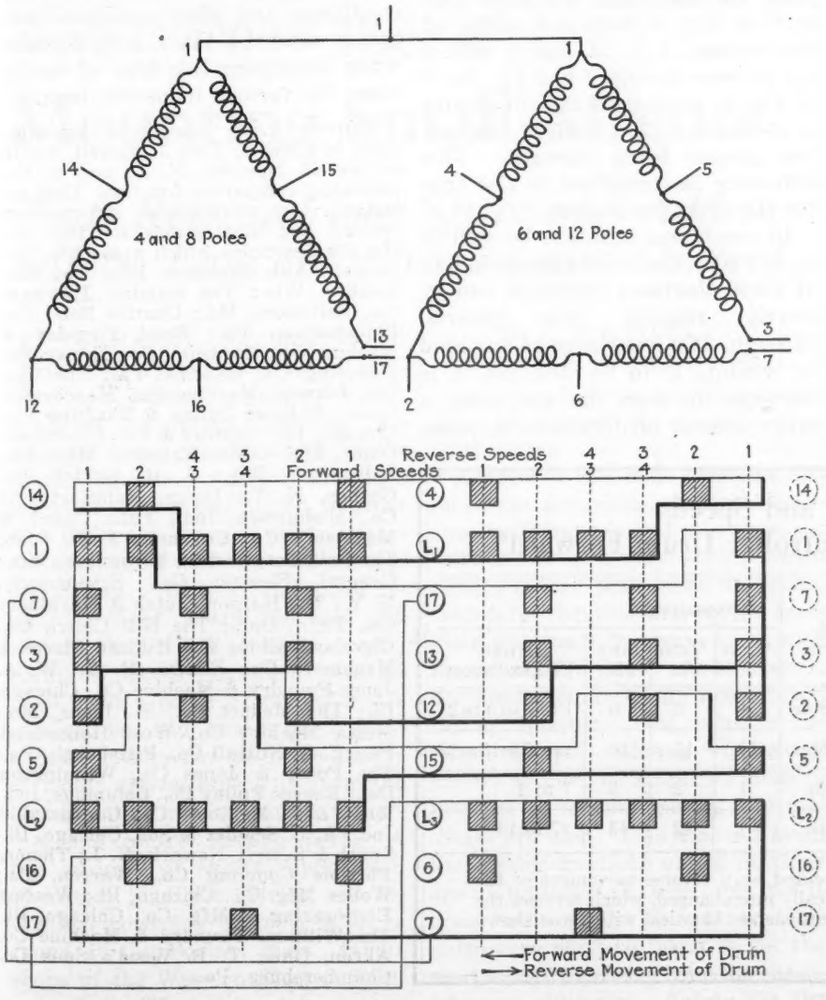
Two-Speed Windings Designed to Give Constant Torque

A two-speed connection which will give the same torque at both speeds is shown in *A*, *B* and *C* of Fig. 4. The high-speed connection is for four poles (salient) and the low-speed connection is for eight poles (consequent). In a motor connected in this way six leads are brought to the outside of the motor. A long-jumper type of connection is used and a tap is made at the center of each phase. The full arrows in the diagram at *A* show the direction of current for the four-pole or high-speed connection while the dotted arrows show the current direction for the low-speed connection. For the low-speed connection, which is shown by the small diagram at *C*, the connection is series star. One permanent star connection is made inside the motor, connecting groups 2, 4 and 6. From diagram *A* it will be noted that the dotted arrows, which show the current direction for the lower speed, are all in the same direction.

The high-speed connection which is shown by the small diagram in *B*, is a two-parallel star arrangement. The permanent star connection between groups 2, 4 and 6 forms one star, while another star is formed by connecting together the leads L_1, L_2 and L_3. Then the line leads are connected on to L_4, L_5 and L_6. Checking the current through according to the full arrows in diagram *A*, it will be seen that the polarity of groups 1, 3, 5, 7, 9 and 11 has been changed. The arrows of alternate groups now point alternate directions, thus making four salient poles. In following out these diagrams, and the others in this article, it might be well for those who are not entirely familiar with the method of checking diagrams with arrows to consult the articles in the September and October issues of INDUSTRIAL ENGINEER, which cover this subject. When changing this winding from the low-speed to the high-speed connection the number of coils or turns in series per phase is decreased by one-half. As the speed, however, is doubled the voltage at which the motor will operate will be the same. Likewise, the paths per phase have been increased from series to two-parallel, and therefore the current in the coils will remain the same. As a consequence, the torque will remain constant but the horsepower will be twice as great with the high speed as with the low speed.

Fig. 6—Controller for a four-speed motor.

This diagram is for the controller which is employed with the four-speed motor shown in Fig. 5. The drum segments are represented by the shaded squares and all of those squares which are in one of the large irregular blocks are connected together on the drum. The controller fingers are represented by the circles. As will be seen there are four forward speeds and four reverse speeds. The various connections which are made for the different speeds are shown in an accompanying table.



Two-Speed Winding With Constant Horsepower

In *D*, *E* and *F* is shown another type of two-speed winding, which in this case, has the same horsepower at both speeds. In this winding a two-parallel star connection is employed for the high speed, and a series-delta connection for the low speed. There are six leads going to the outside of the motor. Three of these leads have two connections, coming from different phases. These are leads L_1, L_2 and L_3. The delta connection as shown in *F* is for eight poles. As will be seen, a tap is brought out from the center of each phase of the delta connection. For the four-pole connection, as shown in *E*, these three taps are used for line leads and the three original line leads are tied together to form a star connection. This reverses groups 1, 3, 5, 7, 9 and 11. With this type of winding the same horsepower is obtained at both speeds, but the torques are different.

A motor which may be run at four different speeds by changing outside connections, and which develops the same horsepower at each speed is shown in the diagrams of Fig. 5. There are two windings on this stator, one winding designed to develop four and eight poles, and another winding for six and twelve poles, using the salient and consequent-pole arrangements.

In these windings a series-delta

connection is used for the high-speed salient poles, and a two-parallel star connection is employed for the low-speed consequent poles. There are seven leads coming from each of the windings, but two of these are tied together inside the motor to form a common lead thus leaving only thirteen leads which are brought outside. No. 1 lead of each winding is connected to No. 1 lead of the other, inside the motor. Leads 13 and 17 form one corner of the delta of the four- and eight-pole winding. When it is in use these two leads are connected together, but when the other winding is in use the two leads are separated, thus opening the circuit while L_8 and L_7 on the six and twelve-pole winding are closed together. When either of the windings is not in use, it must be opened so that there will be no circulating current induced in it by transformer action. If each winding formed a closed circuit, then as only one winding is in use at a time, the active winding would induce a current in the inactive winding, which would prevent the operation of the motor. The coil pitch is 100 per cent, or full pitch, for each respective low-speed connection, and 50 per cent of full pitch for the high-speed connection.

Controller Employed with Four-Speed Motor

In Fig. 6 is shown a diagram of the drum-type controller employed with the four-speed motor shown in Fig. 5. This controller gives any one of four speeds in either the forward or the reverse direction, according to the position of the controller handle. The table shows the speeds and connections obtained when the controller drum is moved forward, for forward speeds.

When connecting up a four-speed, double-winding motor the windings are connected on opposite sides of the motor; therefore when picking up the groups of one winding in a clockwise direction, pick up the groups of the other winding in a counterclockwise direction. If this rule is not followed out the direction of rotation at all speeds will not be alike; that is, the direction of rotation at the 1 and 3 speeds will be opposite to that of the 2 and 4 speeds.

It is interesting to compare the type of winding shown in *D*, Fig. 4, with that shown in Fig. 5. In *E*, of Fig. 4, a two-parallel star connection is used to obtain a four-pole (salient) winding, while in Fig. 5, a two-parallel star connection is used to produce an eight-pole (consequent) winding. Likewise, comparing *F* of Fig. 4 with *B* of Fig. 5, we find again that in Fig. 4 the delta connection is used for eight consequent poles while in Fig. 5 the delta connection is used for four salient poles. A close study will show that in *F* of Fig. 4 there is a series of four groups, 1, 7, 10, and 4, with a tap between groups 7 and 10. In *B* of Fig. 5, this series of four groups is arranged 1, 7, 4, and 10, the last two groups being changed. This difference in connection is also true for the other two phases.

In conclusion it might be well to state that a thorough understanding of these diagrams cannot be had by merely reading this material through. If a knowledge of any kind of winding is to be obtained, it is advisable to draw out and check a large number of different diagrams, which will drill the subject well into mind and reveal many details that otherwise would remain unknown.

Connections and Speeds Obtained on Moving Controller Drum Forward*

Speed No.	Poles	Rev. per Min.		Kind of Connection	Connections			
		60 Cycles	25 Cycles		*Line 1	*Line 2	Line 3	Other Connections
1	12	600	250	2-parallel Star	4	5	6	1 to 7 to 3 to 2
2	8	900	375	2-parallel Star	14	15	16	1 to 17 to 13 to 12
3	6	1200	500	Series-Delta	1	2	3	7 to 3
4	4	1800	750	Series-Delta	1	12	13	17 to 13

*For reverse speeds, which are secured by a reverse movement of the drum, Line 1 and Line 2 are automatically interchanged, which reverses the direction of rotation. All other connections are identical with those shown for forward speeds.

Installation of Flexible Couplings

(*Continued from page 583*)

of carefulness in operation or installation. Second, operating conditions, including overloads, determine the size of the coupling. Third, if the coupling shows excessive wear the cause most probably lies elsewhere.

Because the coupling will take some punishment is no reason for neglect or carelessness. If it did not take punishment it would not serve its purpose as a safety link to protect the more expensive machines it connects. Excessive wear shows that something is wrong and the only preventative is to find the cause and remove it.

The next article of this series will take up the types of cut-off couplings and clutches and their application in industry together with operating conditions and other considerations which must be taken into account when specifying this type of equipment for various industrial uses.

Editor's Note: Special acknowledgment is made to John J. Serrell, Smith & Serrell, Newark, N. J., and to the following companies for their kind assistance in furnishing information, counsel and illustrations for this and the other articles which appear in this series: Allis-Chalmers Mfg. Co., Milwaukee, Wis.; The Bartlett Hayward Co., Baltimore, Md.; Charles Bond Co., Philadelphia, Pa.; Bond Foundry & Machine Co., Manheim, Pa.; Brown Engineering Co., Reading, Pa.; The Carlyle Johnson Machine Co., Manchester, Conn.; Chicago Pulley & Shafting Co., Chicago, Ill.; Conway & Co., Cincinnati, Ohio; The Cutler-Hammer Mfg. Co., Milwaukee, Wis.; I. H. Dexter Co., Goshen, N. Y.; Dodge Manufacturing Co., Mishawaka, Ind.; Falls Clutch & Machinery Co., Cuyahoga Falls, Ohio; The Falk Corporation, Milwaukee, Wis.; General Electric Co., Schenectady, N. Y.; The Hanson Clutch & Machinery Co., Tiffin, Ohio; The Hill Clutch Co., Cleveland, Ohio; The Hilliard Clutch & Machinery Co., Elmira, N. Y.; W. A. Jones Foundry & Machine Co., Chicago, Ill.; The Medart Co., St. Louis, Mo.; Mesta Machine Co., West Homestead, Pa.; R. D. Nuttall Co., Pittsburgh, Pa.; The Pusey & Jones Co., Wilmington, Del.; Reeves Pulley Co., Columbus, Ind.; R. H. & F. M. Roots Co., Connersville, Ind.; A. L. Schultz & Son, Chicago, Ill.; Smith & Serrell, Newark, N. J.; Thomas Flexible Coupling Co., Warren, Pa.; Weller Mfg. Co., Chicago, Ill.; Western Engineering & Mfg. Co., Chicago, Ill.; The Williams Foundry & Machine Co., Akron, Ohio; T. B. Wood's Sons Co., Chambersburg, Pa.

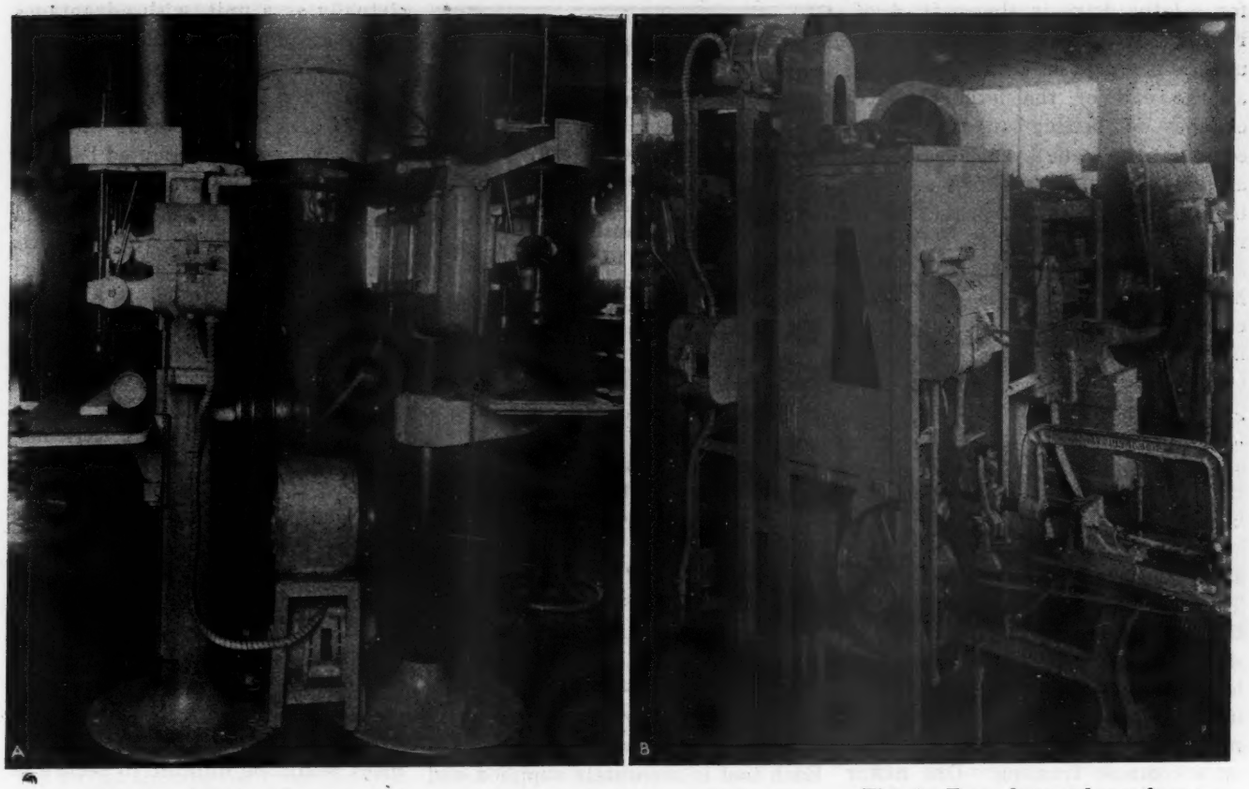


Fig. 1—Two places where the motors take up very little room.
At *A* is a two-story motor mounting. The motors are placed one above the other between the two drill presses which they drive. At *B* a power hack-saw and a boring mill are mounted back-to-back to save space. The motors are so arranged that they require the minimum amount of space. One of them is above the pulleys of the borer and the other is above the back part of the saw inside of a housing.

Some Practical Ways of

Mounting Small Motors

That Release Floor Space and Add to Safety, Ease of Operation and Control

By H. S. KNOWLTON
Contributing Editor, Boston, Mass.

FORMERLY the practice in many shops was to install electric motors anywhere within reach of the driven machines. As long as a tool would run it was a matter of more or less indifference where the motor was placed, so great was the convenience of electric service contrasted with the old mechanical drives. All this is changed today in shops where the tool and motor drive layouts are really planned. Some engineers have almost made a hobby of correct motor applications, and there is much good-natured rivalry now as to the quality of motor drives, especially from the standpoint of motor location, mounting, and control arrangement. A fine example of skillful application of motors in direct driving and individual powering of tools is to be found at the Boston, Mass., repair shops of the Western Electric Company, Inc. What these drives mean in space economy is readily apparent after a study of the accompanying illustrations.

Repairs of telephone exchange and substation apparatus, electrical appliance maintenance and miscellaneous work are done in these shops. Small motors rather than large units are, therefore, required and as the tools used are small in comparison with those found in heavy machine work, the space requirements are of particular interest. The relation between the space volumes required by motors and driven machines tends to increase as smaller motors and machines are used. This does not mean that motor locations and mountings are unimportant in large tools, but it does mean that with smaller tools much care must be taken to get the most out of the drive from the space-economy viewpoint. Safety for the operator and for passing workmen is very important; at the same time motors and control apparatus both need to be within easy access for inspection, for manipulation and for repairs.

Bracket supports for the motor, as in the illustration, Fig. 5, are convenient and compact. Here a 1-hp. motor drives an engine lathe by belting running from the motor pulley to the main driving pulley at the top of the picture. The frame carrying the machine pulley cone is also used to support the motor starting switch which is mounted directly over the chuck, convenient for the lathe operator. The frame is of angle iron 1½ by 1½ by 3/16 in. in size. Flexible armored conductor meets the feed requirements with safety and ruggedness. No ordinary accident seems likely to cut off the motor service. The motor bracket projects slightly beyond the edge of the lathe, but in relation to the size of the tool, the space occupied by the power unit is practically negligible. An entirely different arrangement

for a lathe drive is shown in *A* of Fig. 4. Here the motor, a ¾-hp. unit, is mounted on a hinged bracket at the end of the lathe. Quick changes of belting on the pulley cones can be made by means of this arrangement, and the driving belt being inside, no extra protection is required. As shown, the starting switch is close to the operator's hands. The advantages of flexible conduit for short runs around corners is well shown here. This type of conduit is used extensively in the plant. Still another drive for a lathe is shown in *B* of Fig. 3. The machine at the right is a lathe on which the motor is mounted under the lathe head.

Two excellent examples of ways to save space are illustrated in Fig. 1. True Yankee ingenuity is shown in the "two-story" motor mounting in *A* of Fig. 1. Here two drill presses located on opposite sides of a column are separately driven by 1-hp. motors located one above the other on a common framing. One motor is inclosed by the framing and the other is located on top of it. Angle iron of 1½ in. by 1½ in. by 3/16 in. is also used here, and the framing is bolted into the drill-press bases between the two pedestals. This gives a very convenient and symmetrical arrangement. Both motors are fed from starting boxes mounted on the drill pedestals, with short runs of flexible metallic conduit from the boxes to the motors. A single outlet in the building column is utilized as a center from which to branch-feed the two starting boxes. Each tool is separately supplied and controlled, and yet the two are wired virtually as a unit, with advantages in the amount of material used and convenience of inspection and repairs.

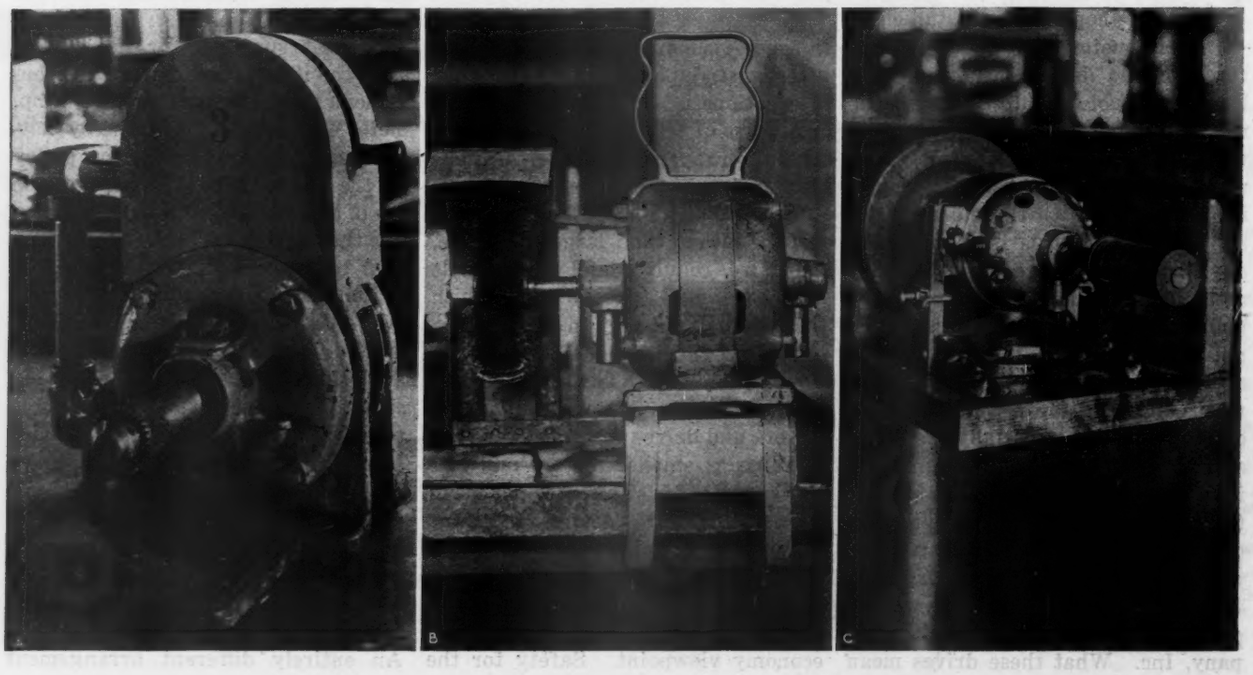
WITH THE increasing use of individual motor drive for machine tools, the problem of where and how to mount the motor and control equipment is of much importance. Any study of this problem must give due consideration to these factors: (1) Saving of floor space by mounting motor and control in out-of-the-way places. (2) Easy accessibility for inspection and repair. (3) Convenience of manipulation by operator. (4) Protection of operator and equipment from injury. This article shows how these factors are combined in mounting motors on machines in the Boston, Mass., repair shop of Western Electric Company, Inc.

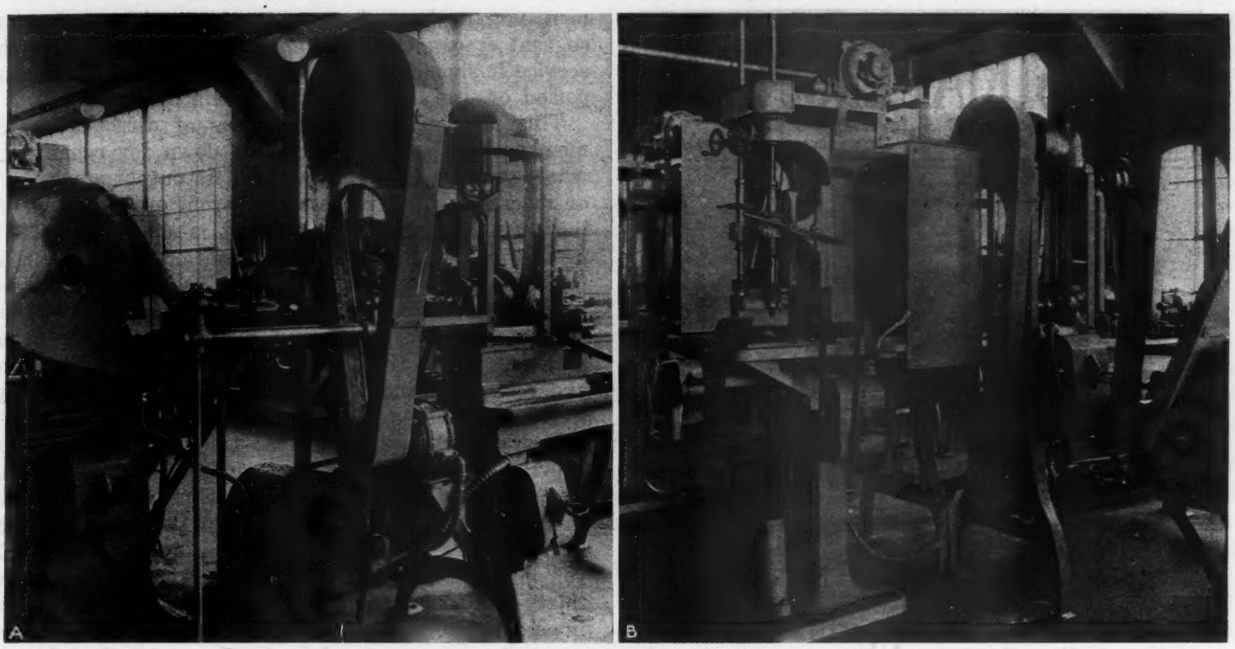
In *B* of Fig. 1 a boring mill and power hacksaw are mounted back-to-back to save space around aisles, the two units being close together and individually driven by 1-hp. motors. The boring mill motor is mounted on top of a light angle-iron frame (1½ in. by 1½ in. by 3/16 in.) which incloses the driving belting and pulleys and forms a convenient mounting for the starting switch shown at the left. The hacksaw motor is even more out of the way, being located in a galvanized sheet-iron housing equipped with a hinged door giving immediate access to the motor. An angle-iron frame surrounds the driving pulleys and belting; thus the unit presents a smooth face to the aisle. The motor itself is mounted on two short horizontal straps fastened to the frame. A more compact belt-driven arrangement would be difficult to secure in this case. The bulkiness of the hacksaw itself is practically the only inconvenience which may be found with the installation.

The punch-press and screw-machine drives shown in *A* of Fig. 3 required motor locations a few feet distant from the main shafts driven. The proper height of motor installation for the punch press (at left) was easily secured by mounting the motor on an angle-iron bracket at the rear of the frame.

Fig. 2—Screwdriving, polishing and coil-winding motors mounted at benches.

A motor-driven screw-and-bolt driver is shown at *A*. The reversing switch on top of the motor facilitates rapid handling of this light work, and rigid conduit feed gives protection to both operator and wiring. A portable polishing motor with detachable clamped straps for bench service is shown in *B*. Ruggedness and portability are well combined in this unit. At *C* there is shown a small motor for winding wire on spools, mounted on a right-angled wooden base and attached to a bench —a good mounting for small motors.





The starting switch was placed on the side of the machine pedestal close by the operator's position, with a metal guard above for protecting the hands and sleeves from the belt. The motor, rated at 1 hp., is placed on two 3-in. by 1½-in. by ¼-in. channels, mounted on a bracket of 1½-in. by 1½-in. by ¼-in. angles set against the machine pedestal at the back. (*Continued on page 611*)

Fig. 3—Angle-iron and strap-iron brackets on the machines hold these motors off the floor.

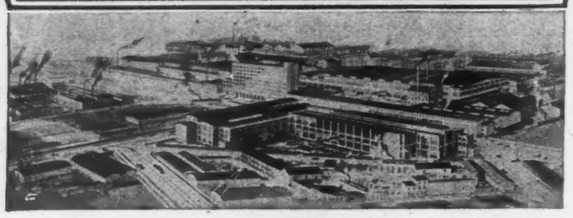
In *A* the motor on the punch press is supported by a bracket at the rear of the machine. The switch is convenient to the operator's right hand. At the right in *A* another bracket supports the motor at one end of the screw machine. The motor mounted above the multiple drill at the left of *B* is entirely out of the way. It rests on U-shaped straps bolted to the frame of the drill. The motor on the lathe at the right in *B* is under the lathe head. It is supported on the cross bracing between the two ends of the lathe. The advantages of flexible armored conductor in wiring short turns such as here are well illustrated. For other lathe mountings see the illustration at the beginning of this article and also *A* of Fig. 4.

Fig. 4—Compact switch and motor arrangement for a lathe and a drill press.

A bracket on the end of the lathe in *A* supports the motor. The pulley and belt are in a protected position underneath the lathe. The operator's hand can reach the switch without any effort. The motor on the drill press at *B* is suspended from a bracket fastened to the frame of the drill.

INDUSTRIAL ENGINEER

Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories



DANIEL H. BRAYMER
Editorial Director

Assisted by

G. A. VAN BRUNT E. H. HUBERT F. E. GOODING

Chicago, December, 1923

If You Follow Some One Else You'll Always Be B hind

WHILE scientists and inventors the world over were proving to their own satisfaction that it was impossible to make a heavier-than-air flying machine and, in view of previous failures, seemed to have all of the evidence on their side, the Wright brothers went ahead and made one. While other automobile manufacturers were making money building expensive cars, Henry Ford started to make a good but cheap car, and thereby laid the foundation for an unparalleled success.

Anyone can follow a crowd, but the men who have been the most successful, not alone in accumulating money but in making noteworthy advances in every line of endeavor, have in many instances been those who got out of the beaten paths and went their own way. Custom and precedents laid down by those who have gone before should be used as aids, not barriers, to progress.

We cannot all be great engineers or inventors or business men, but no matter what our job is, we can do our own thinking and investigating and at least attempt to devise better equipment and better ways of doing things, rather than follow blindly in someone else's footsteps.

One of the great dangers of following others too closely is that they may be going in the wrong direction.

This Is Entirely About You

NOT A WORD of what follows will deal with any detail of your job. What is said refers to YOU, in capital letters. But we are going to assume that you have had some years of experience in the maintenance of industrial equipment and know a whole lot about the ills, the accidents, the minor troubles and the failure of this equipment through neglect, abuse, carelessness and handling by the inexperienced.

You, yourself, are operating and maintaining a very delicate and sensitive mechanism. Yet in spite of what you may know about operation and maintenance unless you are very different from 95 out of every 100 such men, you neglect, abuse and operate this mechanism so that it cannot under any conditions give you the service it should over what is claimed to be its normal period of usefulness at greatest efficiency.

This mechanism has a number of direct-connected members. When one element is down for repairs the whole machine is shut down and its output stops. It's an investment that represents a profit or a loss depending upon how seldom or often it is shut down. This mechanism requires different attention in Winter than in Summer; it burns fuel and leaves a residue and its efficiency in utilizing this fuel varies more widely than that of a steam boiler and requires more attention. Like the boiler this mechanism has auxiliary control and regulation that gets out of order, and when neglected cannot be as quickly corrected or repaired.

You do not need to guess; this mechanism is you yourself—your brain, your stomach, your arms, your legs, feet and hands—the very means with which you earn your living and help to build the success of the institution or works with which you are associated. Do you know that of all industrial workers of the age of thirty-four, seventy-six per cent have some physical impairment or defect that minor medical, dental or surgical treatment or advice can correct and enable the human mechanism to perform its normal operations to the fullest in those years when experience and position secured will bring the largest personal reward?

As a plain business proposition you cannot afford to neglect or carelessly operate and maintain the human mechanism that is you, for on your good health and the exercise of your mental and physical being to the fullest, the developments and progress of this nation depend. If you agree with us that more attention should be paid to the mechanism referred to, then paste this page on your plant bulletin board for the benefit of your associates.

Regular Maintenance Vs. Night and Sunday Rushes

DURING the past two years INDUSTRIAL ENGINEER has presented numerous examples of how maintenance work is handled in different kinds of plants and the results that have been secured through avoiding preventable breakdowns and interruptions of production schedules. It is generally recognized in large plants that general maintenance work should be regarded as a prevention and not a cure for operating troubles. But it is not so generally recognized just how much attention and money can be spent in this prevention work, week-to-week and month-to-month, when things are apparently going all right and troubles are not in sight. It often takes a serious breakdown and regular Sunday rush work to indicate to plant managers that they pay for general maintenance some time and not only that—they lose a lot of production time when they adopt the policy of doing as little regular prevention work as possible and rushing repair work when it comes up.

No group of men in a large works knows more about the troubles with equipment than the men who are called upon to locate them, repair them and take the necessary steps to prevent repetitions of the trouble. When these men are given full responsibility for inspection, overhauling and repair work and this work is organized on a day-to-day routine basis, those troubles that grow from small to serious proportions can

be caught and the remedy in many cases applied with the men engaged in production at machines hardly knowing that anything has happened, and so production goes on and the only charge that the trouble causes is that due to the maintenance time and material.

Maintenance work when well organized in a large plant will cost money or save money in terms of preventable losses in production exactly in proportion to the ability of the men in charge of the work, and the authority and responsibility that is given to them. When they are confined to a repair shop and answer miscellaneous trouble calls through the works they are working at their lowest efficiency and are "fixers" in every sense of the word. A maintenance organization can only secure the results it should when headed by one or more men who know thoroughly the production problems in the plant, the times when rush work must be rushed, the times when materials or machine setups are changed in such a way as to impose a greater or less load on the power circuit and hundreds of other things that constantly change in a production program. These men can then set up inspection schedules, and select times for doing repairs and overhauling so as to fit into the production program at the right point and prevent an interference with it at any other time. Where maintenance work has been placed upon a regular schedule the Sunday rushes are talked about as things that used to be.

Electric Power Apparatus Standards

IN LARGE industrial works standardization of electrical apparatus subject to rough and careless treatment is a matter that is receiving more and more attention from two standpoints: Reduction of stock inventory of parts and miscellaneous fittings needed for repairs; second, ability to carry duplicate and interchangeable units that can be quickly installed in case of service interruptions through failures. At the last meeting of the Association of Iron and Steel Electrical Engineers this matter came up for discussion and it was urged that the holes for the holding bolts of motor frames be spaced in a uniform manner. This is only one of many apparently simple matters that pile up a considerable but unavoidable maintenance cost when non-uniform designs of equipment are in use.

In this problem of standardization the electrical apparatus manufacturers represented by the Electric Power Club have made marked headway. A new edition of their Standards has just been issued and should be secured by every industrial man who has the responsibility for the installation and replacement of electrical equipment. This book gives details of adopted standards and recommended practice not only for motors and generators, but for transformers, mining and industrial locomotives, electric tools, industrial control apparatus, switchboards, circuit breakers and storage batteries and refers to auxiliary mechanical devices such as pulleys, belt and gear drives, shaft extensions and the like.

In view of the agreement on these standards by companies manufacturing more than ninety per cent of the electric power and control apparatus used in this country and the thinking that has preceded their adoption, operators and maintenance men will find the new edition of standards a handy and proper source of information when laying out or checking up on suggested standardization in their plants. A copy of Standards of the Electric Power Club can be secured by writing the Executive Secretary, Keith Building, Cleveland, Ohio.

Look Ahead But Don't Forget to Watch Behind

MANY MEN in industrial positions are frequently disappointed, when promotions are made, to find that someone else has been put into a coveted position when they feel themselves as well or perhaps better qualified. The tendency, often, is to attribute such a selection to "pull" or "drag," which may be the real reason in some instances. However, it usually pays for the man who is left out to make a thorough accounting of himself and his qualifications and strengthen those points which are weak so that he will be able to qualify above all competitors at the next opening.

One point which many men neglect to consider and which the top executive practically always asks is, "How will we fill the place of the man promoted? Has he anyone trained ready to step into his shoes?" If not, even though the man is well qualified otherwise, but few executives will risk disrupting the department operating smoothly and effectively by taking away its head if there is a prospect of getting another man whose promotion will bring forward a substitute ably trained to carry on the old job.

The best place to train men is on the job. This, however, does not exclude the taking of advantage and using additional information supplied by books, magazines, night schools and correspondence courses. It usually works best when both practical and theoretical training are given together. Frequently, men do not impart information to their subordinates because of a fear of letting out the so-called "secrets." Promotions, however, seldom come to those not ready; it comes to those who look forward and watch behind.

Beware of Temporary Installations!

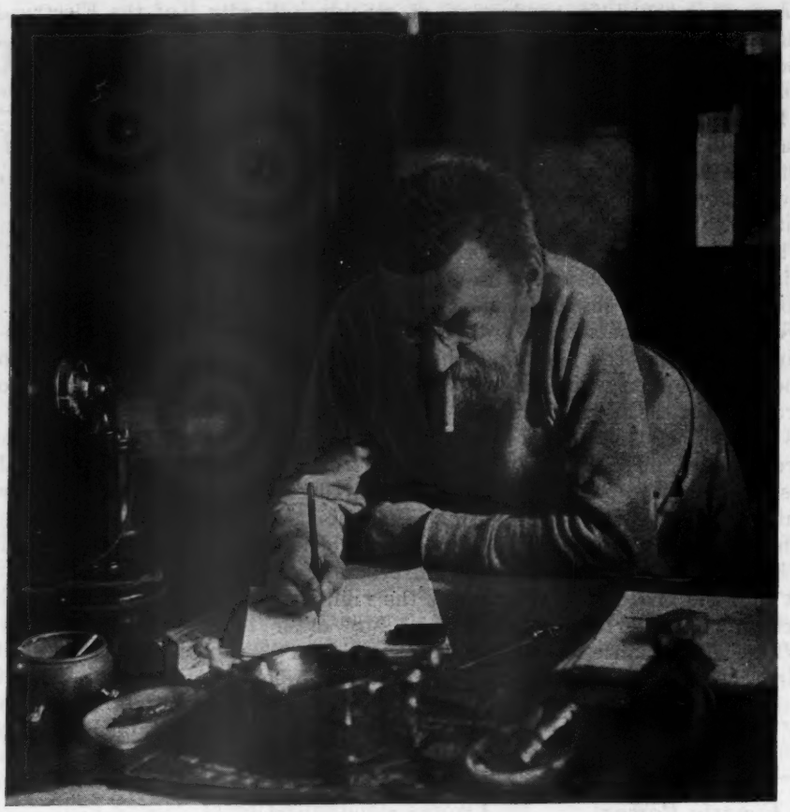
IN ORDER to meet emergency conditions which are presumably of short duration, or a suddenly-increased demand for power service when new departments are added, so-called temporary power circuits are often installed. The intention is, of course, to replace them in a short time with installations of a more permanent character, but in many instances these makeshift additions to the original installation are allowed to remain.

Temporary work is seldom laid out and installed with the same care that is given to a permanent installation and the final result is likely to be a distribution system which is, on the whole, cumbersome, probably inadequate and oftentimes hazardous from operating and safety standpoints. When temporary installations are put in, it is easy to overlook some of the refinements which do much to insure maximum safety to operators and machines, at a cost which is small in comparison with the benefits obtained.

Emergency demands and conditions cannot always be foreseen, but a little thinking will usually show where increased demands for power service are most likely to arise, in plenty of time to provide well-planned and carefully-installed power service extensions.

Charles Proteus Steinmetz

The man and his career as related after his death on Oct. 26 by E. W. Rice, Honorary Chairman of the Board of the General Electric Company.



Dr. Steinmetz in a characteristic pose at work in his own study.

"THIRTY YEARS ago I first met Steinmetz. The occasion was as follows: The General Electric Company had been recently formed by the union of the Edison Company and the Thomson-Houston Company, which brought into one enterprise the results of the work of Edison, Elihu Thomson and many other early pioneers in the fields of arc and incandescent lighting, electric traction and industrial motor application.

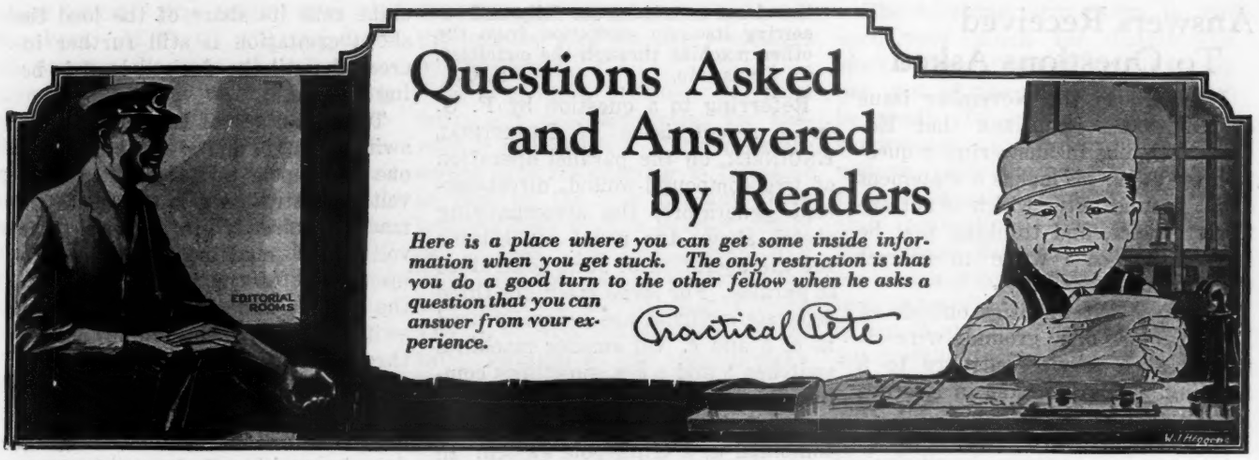
"Rudolph Eichmeyer of Yonkers, N. Y., had developed some interesting designs for electric traction purposes, and certain novel and economical forms of windings for armatures of electrical machines. I was then in charge of the manufacturing and engineering of our company and my views were sought as to the desirability of acquiring Eichmeyer's work. I remember giving hearty approval, with the understanding that we should thereby secure the services for our company of a young engineer named Steinmetz. I had read articles by him which impressed me with his originality and intellectual power, and believed that he would prove a valuable addition to our engineering force.

"I shall never forget our first meeting at Eichmeyer's workshop in Yonkers. I was startled, and somewhat disappointed by the strange sight of a small, frail body surmounted by a large head, with long hair hanging to the shoulders, clothed in an old cardigan jacket, cigar in mouth, sitting crosslegged on a laboratory work table. My disappointment was but momentary and completely disappeared the moment he began to talk. I instantly felt the strange power of his piercing but kindly eyes, and as he continued his enthusiasm, his earnestness, his clear conceptions and marvelous grasp of engineering problems convinced me that we had indeed made a great find. It needed no prophetic insight to realize that here was a great man: one who spoke with the authority of accurate and profound knowledge and one who, if given the opportunity, was destined to render great service to our industry. I was delighted when, without a moment's hesitation, he accepted my suggestion that he come with us.

"Steinmetz had already made his first important contribution to electrical science in investigations of magnetism, and especially in formulating and determining the laws governing the losses in iron subjected to varying magnetic induction. He showed that the hysteresis varied as the 1.6 power of the density of magnetic flux. This made possible for the first time the exact predetermination of the so-called iron losses in the armatures of electric motors and generators and in the transformers and other electrical apparatus employing iron. As a result, the quality of our electrical machinery was improved, and the weight and costs reduced. It is difficult at this date to realize the fundamental importance of this one contribution to the orderly and definite progress of the electrical industry.

"During the first decade of the commercial application of electricity to light and power, which may be said to cover the period between 1880 and 1890, direct current only was used. This was the basis of the Edison system, the Thomson-Houston arc system, and the Vanderpoel and Sprague railway motor systems. The laws governing the flow of direct current were simple and easily understood, and could be treated by mathematics of the most elementary character.

"About the time Steinmetz came with the General Electric Company in 1893, the use of alternating current for lighting, power, and other purposes was just beginning to be of demonstrated commercial value. Advance in the commercial use of alternating current was hindered by the extreme difficulty of understanding the technical nature of its action and of the various phenomena connected t h e r e w i t h. * * * Steinmetz took hold of this situation with characteristic energy, and soon brought order out of chaos. He abolished the mystery and obscurity surrounding a. c. apparatus and soon taught our engineers how to design such machines with as much ease and certainty as those employing the old familiar direct current. * * * It was fortunate indeed for our company and for the electrical industry that Steinmetz became associated with us at the critical time when the alternating current development had just started. It is not too much to say that his genius and creative ability, not only in his own personal work, but in advocating and obtaining the general use of a simple mathematical system for treatment of a. c. problems, was largely responsible for the rapid progress made in the commercial (*Continued on page 612*)



Questions Asked and Answered by Readers

Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.

Practical Pete

Who Can Answer These?

Determining Charging Rate for Storage Battery—Can any of the readers of INDUSTRIAL ENGINEER tell me how to find out from a storage battery at what amperage it should be charged?
Temiskaming, Que., Can. J. H. F.

* * * *

Equalizing Large Generators—I should like to have some reader of INDUSTRIAL ENGINEER tell me how to go about equalizing two 112-kw., 250-volt d. c. engine-driven generators and two rotary converters which furnish power at the same voltage. One of the converters is rated at 150 kw. and the other at 300 kw. They are supplied with alternating current from a public utility company and are modern units of up-to-date design. The engine-driven units are old-type, four-pole machines. I should like to equalize these units by means of resistance shunted across the series field. What losses would be incurred by this method of operation? How should the proper value of the resistance be determined?
Cincinnati, Ohio. R. G. P.

* * * *

What Causes this Magnet Switch to Stick?—We have on a crane hoist a 440-volt a.c. magnetic limit switch which fails to open about one-half of the time when the current is taken off the magnet coil. Although the core is laminated, there is apparently enough magnetism left to hold the switch in. All of the working parts are clean and free. Will someone kindly suggest a remedy for this trouble?
Selby, Calif. J. T. C.

* * * *

Trouble with Portable Electric Drill—I have been having trouble with a Westinghouse, ⅜-in., portable drill. This drill operated satisfactorily for two years and then began running at only half speed. Occasionally it would start off on normal speed, but soon drop back to half speed. I rewound the stator and when this did not clear the trouble I rewound the armature, with no better results. Instead of winding the armature on a form I wound it by hand. So far, I have not been able to get it to run at normal speed.

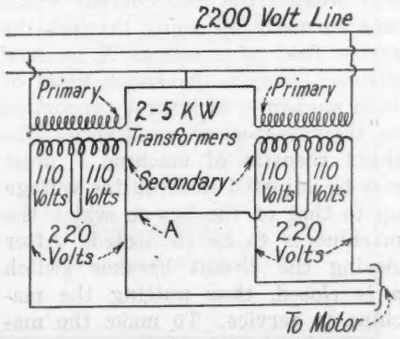
Another portable drill, a Van Dorn, came in recently with the armature roasted. I wound this armature by hand and it, too, ran at half speed. I rewound the armature again, this time on a form but so far have not been able to get it up to full speed although the field coils have been tested out and seem to be all right. The armature core number of the Westinghouse drill is 12-A-876; the Van Dorn armature coil number is Code 8406. Both drills are designed to operate on 110-volt alternating current. I shall appreciate it very much if some reader can tell me what is the matter with these drills.
Philadelphia, Pa. R. I. G.

* * * *

Method of Soldering Leads to Commutator Bars—Can any of the readers of INDUSTRIAL ENGINEER give me the following information: (1) The design of a transformer for soldering the leads to the commutator risers with the aid of carbon electrodes. (2) I have done armature winding on large machines, but would like to know the best way of soldering leads to commutators of fractional horsepower motors, such as fans. I should like to know the type of soldering iron to use, and other information that will help me to save time.
San Francisco, Calif. S. H. S.

* * * *

Trouble in Operating Two-phase Arc Welder Set on Three-phase Circuit—I had occasion recently to operate a two-phase, four-wire, 220-volt, 60-cycle, 1,800 r.p.m. 5-hp. Lincoln motor, which is direct connected to a Lincoln welding generator, on a three-phase, 2,200-volt, 60-cycle circuit. The transformer connection shown was tried. I found that the motor would start but in a short time would get very hot. The wire at *A* was cut and then the motor did not heat so much, so that by stopping the machine about every hour and letting it cool off I was able to do the welding, but too much time was lost. I wish some of the readers of INDUSTRIAL ENGINEER would tell me if this connection is correct and if so, what causes the motor to heat.
Tyrone, Pa. H. L. F.



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Trouble with Commutator Grinding Machine—I recently ground a commutator on a 150-kw. generator with one of the finest tools made, manufactured by the Jordan Commutator Grinding Company, but I did not have much success owing to the rapid wear of the corundum wheel.

When I set the wheel against the commutator it cut a groove, due to the rapid wear of the wheel. Before I could move it an inch along the face with the lead screw the wheel was worn so badly that it would barely touch the commutator. I tried setting it up for very light cuts and turning the lead screw rapidly but that did not help any and it is not a first-class job. The commutator is 14 in., in diameter, 12 in. long and turns at 1,200 r.p.m. The corundum wheel turns at 2,880 r.p.m., cutting against the direction of rotation of the commutator, is ½ in. thick and was 8 in., in diameter at first but when the job was finished it was only 5 in., in diameter.

I should like to know if this trouble is commonly experienced.
New Orleans, La. P. B. A.

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Correcting Power Factor by Synchronous Condenser—I wish to submit the following problem to our readers: *A* is a distributing station supplying power to four feeders, *B*, *C*, *D* and *E*; *B* takes 4,000 kw., *C*, 3,500 kw., *D*, 3,000 kw., and *E*, 2,000 kw. The power factor of these loads is: *B*, 80 per cent, *C*, 78 per cent, *D*, 75 per cent and *E*, 72 per cent, all lagging. It is desired to install a synchronous condenser at station *C*, to give 95 per cent power factor. Would it make any difference in the size of condenser required at *C* if stations *B*, *D* and *E* were to correct their power factor to unity instead of running at 80, 75 and 72 per cent respectively, as at present, (1) in case station *A* has ample generator and exciter capacity and (2) in case this capacity is just enough to carry the load?
Belleville, Ont., Can. J. H. G.

Answers Received To Questions Asked

I noticed in the November issue of INDUSTRIAL ENGINEER that Edward A. Gibbs in answering a question by V. W. M. makes a statement about ground wires which is not entirely correct, and thinking that he is misinformed I write to correct the statement.

He says that in cities outside of Boston only one ground wire is needed at a service entrance to a building. This is not so in Everett, Mass., where two are required.

Our method of grounding is to use two No. 8 ground wires, one for the service wire ground and one for the service conduit ground. We do allow a piece of ½-in. conduit to be run from the service switch to the point of attachment to the water pipe. This conduit is to contain one No. 8 wire which is used to ground the service. The conduit is then bonded to water pipe with a separate piece of No. 8 wire and forms a second ground for a service conduit and main switch cabinet. In any case two separate ground clamps must be used on water pipe.

These grounds need not be run back of water shut-off unless the equipment is the only one on the transformer, in which case they must.

I would add that service conduit which is insulated from other metal work in building and is so located that it is out of reach of anyone on the ground or other grounded metal work is not required to be grounded.

PERCY A. BLAISDELL.

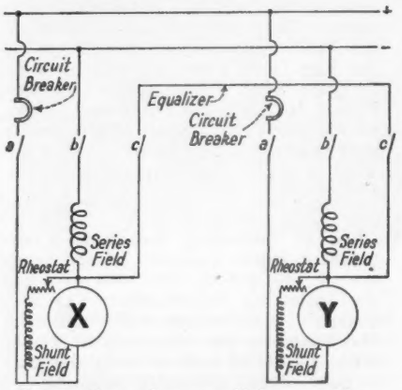
Inspector of Wires,
Everett, Mass.

* * * *

Operating Two Direct-Current Generators in Parallel—We have in our plant two 300-kw. d. c. generators. These machines are wound series compound, are equipped with equalizers and are connected in parallel. They are in continuous operation, except that once in 24 hours they are shut down for about 10 minutes for cleaning. We leave the resistance on the shunt field in the same position as when running, as there is no load on the machine. We trip the breakers and pull the equalizing switches out. I should like to know, however, if the machine is likely to be damaged in starting up again in case the engineer should shut down with the resistance fully cut in on the shunt field and both breakers tripped, but with the equalizing switches in. The running voltage of this machine is 250 volts. When starting up with the resistance cut in the machine does not build up the voltage. I should like to know what voltage the incoming machine would build up with the shunt resistance cut fully and receiving its only excitation from the other machine through the equalizer.

St. Louis, Mo. F. G.

Referring to a question by F. G. in a recent issue of INDUSTRIAL ENGINEER, on the parallel operation of two compound-wound, direct-current generators, the accompanying sketch shows the usual connections for the operation of such generators in parallel. For large machines three separate switches are generally used at *a*, *b* and *c*. On smaller machines switches *b* and *c* are sometimes combined to form a double-pole switch, although in most cases they are all combined in a triple-pole switch. In some cases where the machines are at a considerable distance from the main bus, the equalizer is often run straight between the machines and the switch eliminated.



Connections for parallel operation of two compound-wound direct-current generators.

Assuming that generator *X* is running and it is desired to start up *Y* it will be necessary first to bring the machine up to speed with switches *a*, *b* and *c* open. If we now close the equalizer switch *c* nothing will happen, as no closed circuit will be formed. If in addition we close switch *b*, a circuit will be formed through the series winding of machine *Y*. The result will be a lowering of the voltage in machine *X*, due to the fact that the excitation of this machine is now less because the load current which was formerly all going through the series field of machine *X* is now divided between the series fields of both machines, in inverse proportion to their respective resistance. The shunt rheostat of machine *Y* must now be adjusted to bring the voltage up to that of the bus to which the machine is to be connected. After closing the circuit breaker switch *a* is closed, thus putting the machine in service. To make the machine take its share of the load the shunt excitation is still further increased until the desired load is being carried.

The advantage of having the three switches *a*, *b* and *c* combined into one triple-pole switch, is that less voltage disturbance is caused to the machine already in service. The voltage of machine *Y* is brought up to that of the bus by means of the shunt rheostat. The three switches are then simultaneously thrown in and the series field excitation on the incoming machine causes it immediately to take some of the load, thus making up for the voltage drop in machine *X*, due to the lower series field excitation.

In starting the two machines up from standstill it is evident that no harm could be done by having the equalizer switches *c-c*, of both machines closed. Switch *b* of both machines could also be closed without causing any current whatever to flow in the series fields. As soon, however, as the circuit breaker and switch *a* of either machine are thrown in, a circuit is set up between the positive bus, through the armature of the machine connected, and through the series fields in parallel to the negative bus. The voltage will depend upon the adjustment of the shunt rheostat of the machine connected and the excitation caused by the series fields will depend entirely upon the load.

With switches *b* and *c* closed the voltage of an incoming machine would not build up very much if the shunt resistance is cut fully even if the load on the machine in service were heavy, causing maximum current through the series fields, because the series fields are usually designed to vary the normal voltage by only a relatively small percentage of the total. FREDERICK KRUG.

Comerio Falls,
Bayamon, Porto Rico.

* * * *

In reply to the question by F. G. in a recent issue, if the two machines are connected standard the shunt fields are energized by taps taken between the brushes and the circuit breakers. The equalizers are usually connected directly to one brush lead. With both legs of a double-pole circuit breaker open on each machine there is no way in which current can flow to cause damage. If on the other hand single-pole breakers are used and improperly connected the closing of the equalizer would cause a practical

short circuit that would open the breakers. If F. G. will put down on paper a diagram of the connections of the two machines he can easily see what will happen by tracing out the possible current paths when the breakers are open or closed, or the equalizer is open or closed, and so on. If he has a closed circuit and a live machine, current will flow. If his current cannot come through, then no shorts will occur.

Seattle, Wash. W. M. PRICE.

* * * *

Voltage from Transformers Connected in Different Ways—I should like to get an expression from readers of INDUSTRIAL ENGINEER as to their experience in connecting transformers open delta, closed delta and star. Please show, if possible, a sketch covering each of these connections and the voltages at 2,300, 1,100 and 440 volts. Perhaps someone can tell me where I can purchase a book which covers such subjects.

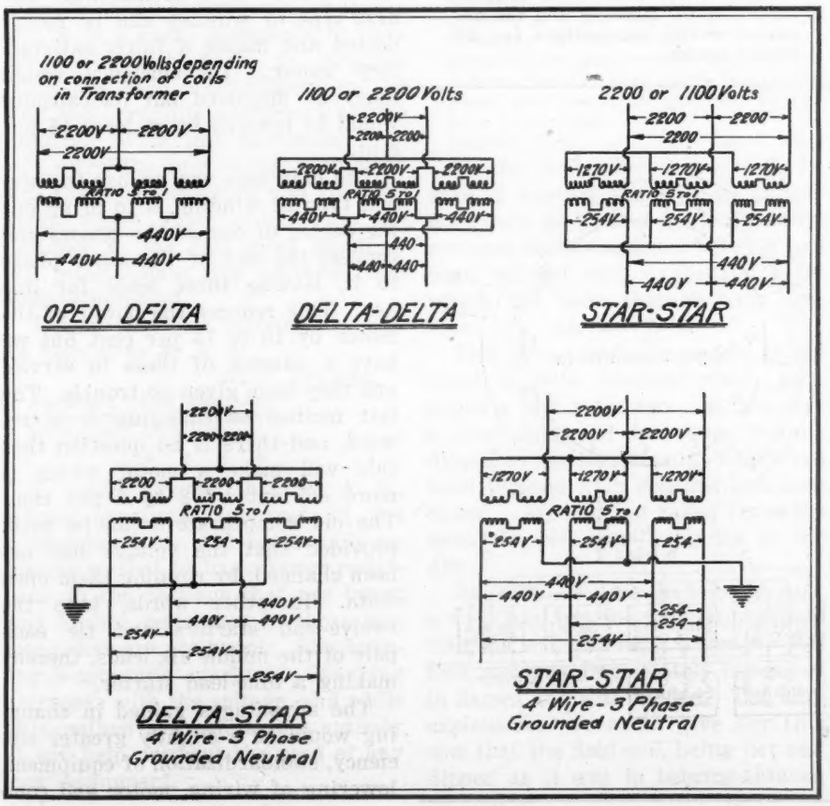
St. Louis, Mo. F. W. Mc.

Replying to F. W. Mc., who asks in a late issue about transformer connections, I hope the following information will be of some use.

The current and voltage in an open delta connection are 30 deg. out of phase with each other, resulting in an internal power factor of 86.6 per cent. The ratio of the energy delivered to the energy supplied is, 1 to 1.15. For this reason the open delta should be used in emergency only. Standard transformers of similar characteristics can be used and the primary and secondary voltages will be normal.

Delta-delta is probably the most frequently used connection for low-voltage distribution. The pressure across each transformer is the same as that on the line and any three transformers of like characteristics can be used. The total current in a delta bank will be 1.73 times the full load current of any one transformer. The secondary voltages will be the rated voltages of the transformers. This connection eliminates the third harmonic voltage from the line, as the magnetizing currents which cause it are circulated through the deltas. However, before installing a delta bank it is well to consider some of the disadvantages incident to its use: (1) A short circuit across any one unit constitutes a phase-to-phase short circuit and will impose heavy stresses on all of the windings. (2) If any one line becomes grounded the voltage stress in the other members of the circuit is raised to 1.73 times normal. (3) Large circulating currents can be set up in a delta-connected bank by slight differences of ratio and impedance in the individual units.

Various methods of connecting transformers in primary and secondary sides, with the voltages obtained.



The star-star connection is not used very much for distribution work as transformers wound for 58 per cent of the phase voltage must be used. To insure stability and suppression of the third harmonic voltage especially designed transformers should be used with the star connection. The four-wire, three-phase, delta-star connection is one which is coming into general use in late years. It is particularly well suited to grounded-neutral, low-voltage distribution systems. The primary may be star or delta, as conditions indicate. The secondary must be star. If a star primary is used the winding is rated at 57.7 per cent of the line voltage. If delta, the primary rating equals the normal line voltage. The secondary voltage is 1.73 times the rating of the individual unit and the voltage of any one phase wire to the neutral is 57.7 per cent of the voltage between phases. This system when connected delta primary, star secondary, combines the advantages of both methods of connection without a good many of the disadvantages of both of them. D. F. O'DONNELL.

Chicago, Ill.

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In answer to the question by F. W. Mc. in a recent issue regarding books which cover transformer connections, I would recommend a book entitled "Wiring Diagrams of Electrical Apparatus and Installations." This book, which will illustrate and explain just what he wants to know about transformer and many other connections in which he may be interested, can be obtained from the McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City. GEORGE ZEHNACKER.

Haledon, N. J.

* * * *

In reply to the question asked by F. W. Mc. in a late issue regarding various transformer connections, the most commonly used methods of connecting transformers on three-phase systems are: delta-delta, star-star, star-delta, delta-star.

When transformers are connected delta on both primary and secondary sides the secondary voltage will, with a 10-to-1 ratio transformer, be 1/10 of the primary voltage or, using primary voltages of 2,300, 1,100 or 440, the secondary voltages will be 230, 110 or 44 volts respectively.

Using the delta-star connection the secondary voltages will be 1.73 times the value for the delta connection, or 398, 190 and 76 volts respectively.

With a star-delta connection the

secondary voltage is 57.7 per cent of what it would be with the delta connection or 133, 62 or 25 volts approximately.

The V, or open delta connection is generally used only for comparatively small loads or in case of damage to one unit of a bank. Since the line current passes through each transformer, the rating of each should be 0.577 of the total kva. of the load.

Detroit, Mich. JOHN B. RAKOSKE.

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Rewinding Motor for Four Speeds—We have a 5-hp., 1800 r.p.m., 220-volt, 3-phase, 60-cycle induction motor which has 48 slots in stator and is wound with 24 coils made of 13 turns of No. 15 wire. This motor is now connected single star. There is room in the stator for another winding due to there now being only one coil in each slot. There are 55 bars in the rotor. Short circuiting rings are ½ in. square, laminations 3¾ in. wide.

We would like to know if it is possible to rewind this motor with two sets of winding and secure four speeds: 600, 900, 1200 and 1800. The horsepower required at slow speed is about one.

Logan, W. Va. B. S.

In answer to the question of B. S., the four-pole winding must be wound in the stator first, and have 25 turns per coil of No. 19 magnet wire with a coil pitch of 1 and 7 and group 4 coils in series (the same as any four-pole machine). The six-pole winding is next wound in the stator with 34 turns per coil of No. 19 magnet wire with a coil pitch of 1 and 5. The groups are the same as any six-pole, 48-slot stator with an odd grouping of 3-3-3, 3-2-3, 2-3-2, 3-3-3, 3-2-3, 2-3-2.

This winding will give you approximately 1 hp. at the lowest speed and approximately 4 hp. at the highest speed. In other words, your motor will be a constant torque motor.

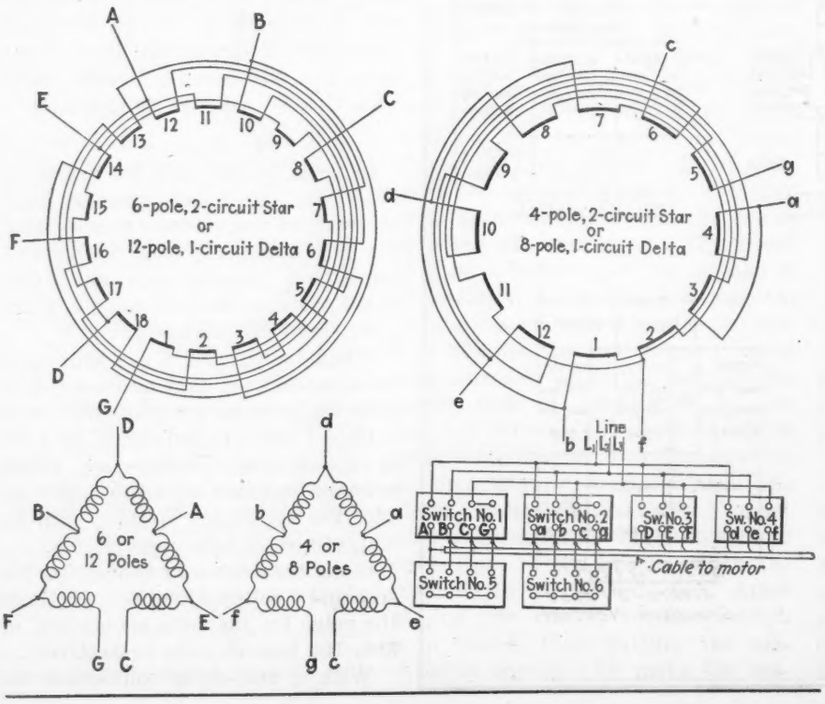
I am giving a set of motor connections and switch connections to show how to connect up the machine to the line without any trouble. If you happen to have a controller I can also send you a controller print. I infer that you are not using a controller so I am not including the connections.

You will have to use two, three-pole switches and four, four-pole switches of 30-amp. rating. I have twelve such machines operating with switches and four machines with controllers. The machines using switches must have more highly skilled men to operate them.

All motor leads must be numbered when the machine is being connected up by the winder in order to avoid trouble when the machine is completed. I might also add that if it is possible to use No. 18 B. & S. gage magnet wire in the machine, I would do so, as it will give you better starting torque under full load conditions.

Superintendent, Elliott Electric Co., Shreveport, La. GUSTIN R. LIEBER.

Diagrams for four-speed constant torque motor winding and the necessary switch connections for different speeds.



Changing Two-Phase Motors to Three-Phase—In our plant we have sixteen motors ranging from 3 hp. to 50 hp., making a total of 210 hp. These motors are wound with four to eight poles. We are considering putting in additional equipment and I shall appreciate it if some reader will answer these questions: (1) Would it pay to change over to a 3-phase system? (2) What saving would there be, if any, in power consumption? (3) Would it be necessary to rewind these motors to change them from 2-phase to 3-phase? (4) Would such a change increase the efficiency of the motors?

Jeannette, Pa. A. W. G.

With reference to A. W. G.'s question in a recent issue, if the additional equipment will be 50 per cent or more of the present equipment, it is likely that it would be better to make the change as eventually there will be little two-phase current available. Then it will be difficult for him to obtain other than special motors. I doubt if the question of efficiency would be worth considering as the three-phase equipment is usually only a very few per cent more efficient than the two-phase.

The procedure involved in changing the motors from two-phase to three-phase will have to be determined by the machines in question. Some manufacturers insulate each coil so that the two-phase grouping can be broken without danger. Others insulate groups only and when a group is broken there would be a chance of a breakdown. The first type of winding can be reconnected and makes a fairly satisfactory motor. Its efficiency would likely be improved but its capacity would be lowered by at least 15 per cent.

The only safe way to use the second type of winding is to bring out the center of one of the phases and connect the end of the other phase to it, leaving three leads for line use. This reduces the power of the motor by 10 to 15 per cent but we have a number of these in service and they have given no trouble. The last method of changing is to rewind, and there is no question that this will make a motor which is more efficient by 2 to 5 per cent. The old compensators can be used, provided that the voltage has not been changed, by running them open delta. In other words, take the twelve-lead starters and tie each pair of the middle six leads, thereby making a nine-lead starter.

The advantages gained in changing would be a slightly greater efficiency, standardization of equipment, lowering of wiring, motor and com-

pensator cost, and a probable reduction in the number of burnouts owing to the elimination of one fuse and a double circuit.

Seattle, Wash. W. M. PRICE.

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Trouble with Control Equipment of Slip-Ring Motor—I wish some of the readers of INDUSTRIAL ENGINEER would answer the following questions: (1) I have to take care of two 20-hp. slip-ring motors which are controlled by rheostats and magnetic switches. I am now having trouble due to burning of contacts on the rheostats. About half of the segment contacts, counting from the starting position, are affected. The brushes seem to make good contact on the rheostats. This equipment is in use in a stone quarry. Could excessive dust be the cause of this trouble? (2) What is the best equipment to use for testing motors up to 30 hp. for grounds, shorts and so on? (3) I have a 5-amp., 3-cell, vibrator-type battery charger, operating at 110 volts, 60 cycles, which is very noisy. Can this type of charger be silenced to any extent?

Intercourse, Pa. M. A. D.

In the September issue, M. A. D. reports a case of trouble with the control equipment of a slip-ring motor. In answer to his question I should like to inform him that excessive dust or foreign material is no doubt causing the trouble described.

Frequent cleaning of the switch parts would keep burning of contacts down to a minimum. As is the case with most starters where there is much foreign matter in the air, it is a great advantage to have as few switch parts as possible. This has been accomplished in the enclosed, graphite compression type control. With this particular type of control the only switch parts used are the line contactors and the contacts which short circuit the resistance in the full speed position. All intermediate step contacts have been eliminated.

I trust that this information may be helpful to M. A. D.

W. F. PFEIFER.

Assistant Chief Engineer,
Allen-Bradley Company,
Milwaukee, Wis.

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I would suggest that M. A. D., whose questions appeared in the September issue, (1) respace his resistors so that he has a lower resistance in the sections that are burnt and higher resistance in those sections that are not burnt. The burning is caused by sparking. Sparking increases with the voltage, and while this method will not clear it entirely it will help, without the need of any new equipment.

(2) Shorts will take care of themselves and show up very quickly in the way of hot coils in the stator or sticky spots that will prevent the rotor starting when under live poles. I use line voltage through lamp resistance to test for grounds. A ground that will not spark will not make trouble immediately, if at all. A full ground will show up with a bright lamp.

(3) Placing the vibrator on a non-resonant base is about all that it is possible to do in the way of deadening the noise. W. M. PRICE.

Seattle, Wash.

* * * *

Explosion of Totally-Inclosed Motor—I should like to know if any readers have had accidents similar to the following: The stator of a totally-inclosed, split-phase, ½-hp. motor was rewound and after assembly was given an hour's running test. It was then shut down to see how the starting torque compared with a motor of a different manufacture. After a few trials the motor was allowed to come up to speed, but as soon as the click of the starting winding cut-out was heard, it exploded violently, and was broken into a number of pieces.

In this shop black asphaltum paint was used on all windings. At times this paint got thick and was thinned down with benzine. This motor was assembled right after it had been painted, and inasmuch as it was a totally-inclosed motor, heat generated by the winding evaporated the benzine. The starting torque trials made matters worse. Then the motor shaft was released to allow it to come up to speed and as soon as the centrifugal, starting-winding switch operated, a spark was formed on the breaking of the circuit. This spark exploded the gas, wrecking the motor. I have been in this game for twelve years and this is the queerest experience I ever had.

Denver, Colo. A. J. M.

In the September issue A. J. M. asks if anyone has had an experience such as he had when a totally-enclosed motor exploded after it had been painted with asphaltum paint which had been thinned with benzine.

This queer explosion recalls to my mind a little incident which happened a few years ago. In this case a new field coil had been wound, dipped in asphaltum paint which had been thinned with benzine, and then baked. After being taken from the oven the coil was hung up to air dry.

As soon as this had been done a workman put the test leads across the field leads, causing a spark. The field coil was immediately enveloped in flames and was spoiled. The only explanation we could give for this was that the field coil, being hot and dipped as it was in benzine-thinned paint, was giving off gases that were inflammable.

While my explanation of the cause of this incident in my own experience may not be correct, for the benefit of A. J. M., I will state what I have done since then to prevent similar trouble, and suggest that others who have to dip and bake coils do likewise.

I always bake, for a few hours, any work on which paint thinned with benzine has been used, and then after removing from the bake oven, give the job a chance to cool thoroughly by air drying before tests of any kind are made. In the case of a rush job, where the time cannot be spared for baking and air drying, I use an air-drying lacquer for impregnating. This allows tests to be made or the apparatus to be put into service as soon as the assembly has been completed.

This method has proved to be very reliable and I have never experienced any trouble with it. I sincerely hope that other readers will benefit from the accounts which A. J. M. and I have given of the two cases of hard luck which we have had.

E. H. SHRIVER.

Master Mechanic,
Irving Smelting & Refining Works,
Irvington, N. J.

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I have read with interest the account by A. J. M. in the September issue, of the explosion of a ½-hp. motor while under test after being rewound. The particular grade of varnish used on the coils of this motor does not absorb all of the solvent unless it is well stirred. If the varnish filled all of the air holes, I can understand why the motor was blown up. The heating of the coils would drive the solvent out in the form of vapor. When this was mixed with air it would form a very inflammable mixture which would be likely to explode when the starting switch opened. A. C. ROE.

Detroit, Mich.

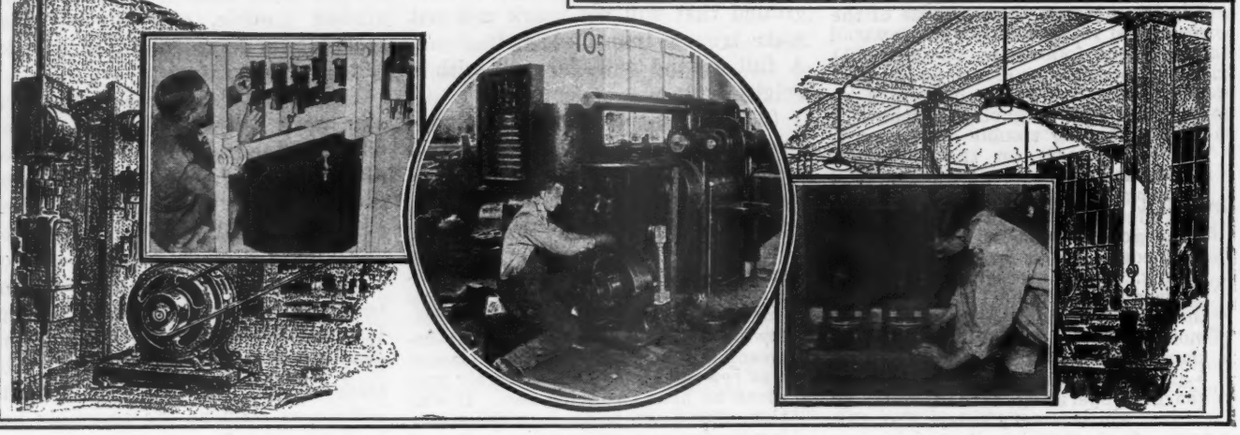
* * * *

I think the answer to A. J. M.'s question in the September issue is that the motor should have been thoroughly dried out before it was run or tested, as benzine vapor and a spark is a dangerous combination in any total enclosure. This incident reminds me of a motor that I once saw set afire by a spark from its brushes igniting all of the field and armature windings after these had been washed with gasoline-soaked waste. H. S. RICH,

New Britain, Conn.

SERVICE
around the works

For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.

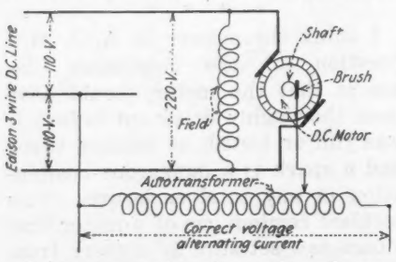


Easy Method of Obtaining Alternating Current From D. C. Machine

IN THE August issue of INDUSTRIAL ENGINEER, Philip G. Bernholz describes a method which he uses to obtain alternating current from a d. c. machine. I believe that, with conditions favorable, the following way of doing this is far better and much easier to put in operation.

Most d. c. motors are operated on twice the voltage of the lighting circuit on what is commonly called the Edison three-wire system. This offers an exceptional opportunity of getting alternating current for testing, by the following method: Obtain a good ground on the armature of a motor, which can be easily done by grounding one bar of the commutator to the shaft. When this is done, alternating current may be obtained from the shaft and the neutral of the three-wire system. I used an auto-transformer to get the correct voltage, as shown in the illustration. It would be best to have a brush on the shaft but I ran without one by simply grounding to any part of the motor frame.

R. M. BEECHER.
Buffalo, N. Y.



One commutator bar of a d. c. motor is grounded to the armature shaft and alternating current taken from the shaft and the neutral of the three-wire system.

Wet Straw Aids Removal of Concrete Foundation When Blasting

THE PROBLEM of removing concrete foundations without disturbing or damaging adjacent operating machines presents a complicated task to the industrial engineer. Drilling and wedging out the concrete, or breaking it with a skull cracker are both slow, tedious processes and in addition create a fine dust which may settle in and damage bearings of adjacent machines. The use of a skull cracker is usually prevented by the inconvenience of installation for such a small operation.

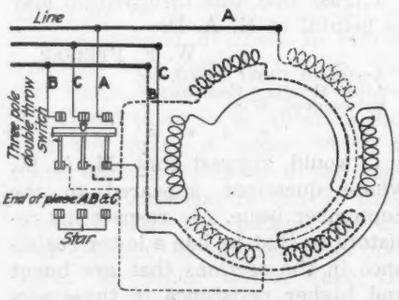
In one plant, blasting out a large concrete foundation in an engine room was tried. Thirty cubic yards of old concrete foundation in a power house were being removed to provide room for a new turbo-generator. In this case it was decided to blast out with dynamite. When the work was first started wood beams and tarpaulins were used, but were not satisfactory as they tended to fly about with each explosion and threatened to interfere with the turbines in operation close by. Finally, gunny sacks filled with straw and wet thoroughly were piled over the foundation while blasting. This deadened the shock and also prevented all but comparatively small pieces of concrete from flying around. In addition, an 8-ft. fence was built around the excavation to catch any small pieces which flew out at the sides from under the sacks. The wet sacks also kept down the fine dust which is so destructive to bearings.

H. C. A.
Chicago, Ill.

Use of Star-Delta Connection to Start Motor Under Heavy Load

WE RECENTLY had a 3-hp., delta-connected, three-phase motor which overheated on starting. This was a 3,600 r.p.m. motor and was used for driving a tar purifier having a cylinder which runs about 18,000 r.p.m. when up to full speed.

The motor was started by throwing it directly across the line. Before it reached full speed it would be so hot that it would smoke freely.



When the switch is in the lower position the motor is connected in star. The windings receive 58 per cent of the voltage they receive when the switch is thrown upward, which gives a delta connection and is the running position.

As a motor draws from two to three times normal current when starting and several seconds were required to bring the cylinder from rest to full speed the stator coils became very hot. After the purifying machine had reached full speed the motor would take care of the load, and its temperature would not exceed its rating. On examination of the motor it was discovered to be series-delta connected, so that the star-delta method of starting could be used. Therefore, in order to make the starting conditions less severe we arranged the motor to start connected in star and, after starting, to operate with the delta connection. The accompanying drawing shows how his was done.

As shown in the drawing the leads were brought outside the motor. A three-pole, double-throw switch was mounted near the motor with a lead from each line brought to the top terminals of the switch. Each phase lead from the motor was connected to the switch, as shown. The three bottom terminals of the switch were short circuited. When the switch is in the upper position the motor is series-delta connected and when in the lower position it is series-star connected.

The motor is started with the switch in the lower position, which gives the star connection and allows it to come up to speed slowly and without excessive heating. When the machine reaches full speed the switch is thrown in the upper position which gives the delta connection.

EARL BABER.

Illinois Power & Light Corp., Galesburg, Ill.

Power Saved by Use of Water Rheostat in Rotor of Pump Motor

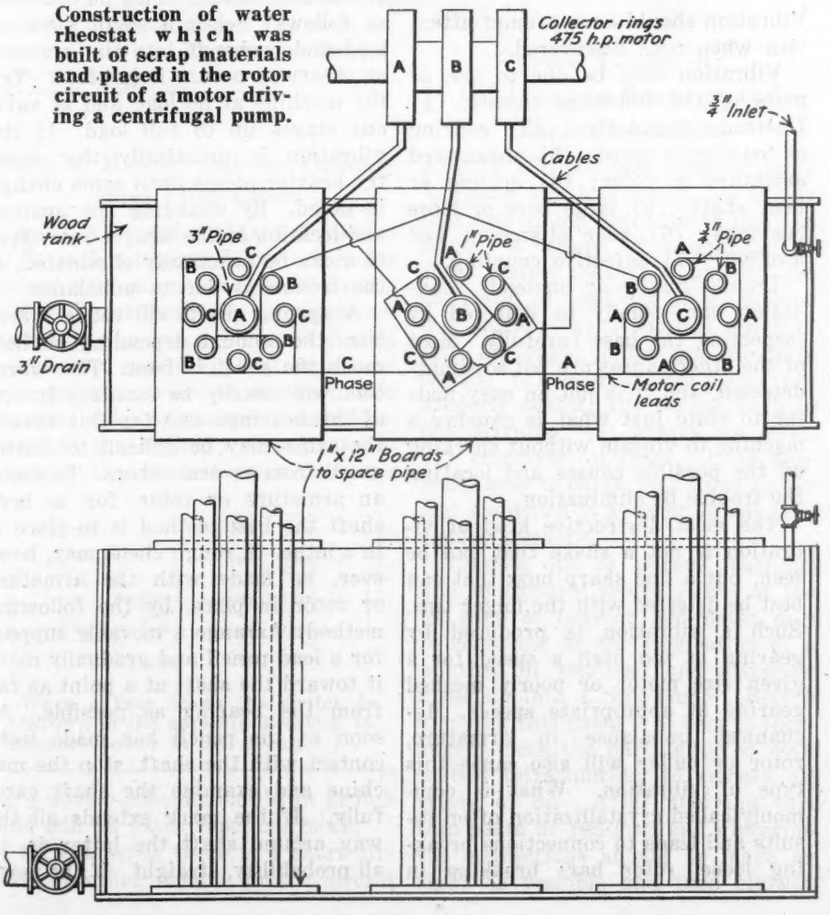
WE HAVE a 475-hp., 1170-r.p.m. 2,300-volt, three-phase slip-ring induction motor coupled directly to a 16-in. centrifugal pump operating under a 160-ft. head. As this was a booster station and the static head was 280 ft. the total head would be 440 ft. with the booster pump in operation.

After a series of experiments it was found that the pipe line would only withstand a maximum pressure equivalent to a 410-ft. head and this pressure was maintained by means of a by-pass valve cut in between the suction and discharge headers. By slightly opening this valve, water would pass back from the discharge side to the intake side.

As we were pumping into storage reservoirs which were constantly filling up or running down, the pressure was hard to maintain and the operator had his hands full. This method of regulation, while it worked, was very inefficient as the electrical horsepower input was 530 hp. while the pump was delivering only from 250 to 475 water-horsepower.

It was not deemed advisable to change the pump design, as later on the full head would be needed. After considerable thinking I decided to reduce the speed of the motor by means of a water rheostat cut in on the secondary or rotor circuit. I did not wish to purchase any new materials or equipment, as the idea was to save money; so I went to the junk pile and found an old mixing tank about 5 ft. long, 4 ft. deep and 2 ft. wide. There was also an assortment of iron pipe ranging from ½-in. to 3-in., in random lengths. I was forced to purchase 36 ft. of cable for the connection between the slip rings and the rheostat. For the connection between the pipe electrodes I stripped the insulation from a number of damaged motor coils; this gave me a supply of ⅛-in by ¾-in. copper strips.

I did not have much data as regards current and voltage on the secondary circuit at reduced speed, as an ordinary ammeter and voltmeter would not operate owing to the low frequency. However, I started the motor and with the starting resistance cut in about 50 per cent, I got a speed of 1,000 r.p.m. At this speed a 110-volt lamp across the slip-ring terminals burned at nearly full brilliancy, at maximum voltage. From these results, I assumed that the voltage would be about 100, on the average. From data which I already had, I knew that I would get a voltage drop of about 2,000 volts per sq. in. of gap at a current density of 1 amp. per sq. inch, using pure water as a solution. Owing to the high voltage at starting, 629 volts, I did not wish to have less than a 1-in. gap; so I had to figure on a smaller current density at normal speed. I thought that a current density of about 1 amp. per 9 sq. in. would be about right and estimated the average current to be 200 amp. Then, 200 amp. × 9 sq. in. = 1,800 sq. in. required per phase.



Construction of water rheostat which was built of scrap materials and placed in the rotor circuit of a motor driving a centrifugal pump.

This was obtained as follows: Three 3-in. pipes immersed 48 in. in the solution equals 1,584 sq. in. Sixteen ¾-in. pipes gave an area of 2,304 sq. in. Eight 1-in. pipes gave 1,600 sq. in. area, or a total of 5,480 sq. in., which equals 1,829 sq. in. per phase. This was equalized by mounting the 3-in. pipes upright in the tank and surrounding them with eight smaller pipes spaced to allow 1-in. gap. This number of pipes and the spacing also gave the required gap between the 3-in. pipe and the smaller sizes.

The accompanying diagram shows the connections and when the rheostat was put into operation the phases balanced exactly. With a full load it was found that about 1,010 r.p.m. was required. My calculations and estimates were so close that this speed could not be reached except by adding a small amount of salt to the water in the tank. I was, however, surprised to find that the power factor which was normally 90 per cent now stood between 91 and 92 per cent. After the unit had been in operation four hours the water reached the boiling point and the motor had a tendency to speed up. This was overcome by draining out the hot water and adding cold.

The unit, as a whole, was very nearly self-regulating owing to the fact that the pump impeller was designed for a dropping power curve under maximum flow. This characteristic tended to stabilize the operation of the unit, as when the pressure showed any tendency to rise the extra power required automatically slowed down the motor. As a result when the desired pressure was reached the unit became very nearly automatic as regards holding this pressure.

A 24-hr.-per-day test, which lasted a week, was made and the results may be summarized as follows:

	Normal Operation	With Rheostat On
Speed, r.p.m.	1,170	1,000 to 1,150
Kilowatts	400	250 to 350
Power factor	90	91 to 92
Gallons per day, same both runs.		
Kilowatt-hours	9,000	7,500
Net saving per 24 hours		1,500 kw.-hrs.

This saving just about pays the operator's salary. The saving on the first day's run paid for the cable, and as the operators themselves installed the equipment and scrap material was used throughout, the remainder is clear profit. The outfit as shown was not built to be operated in regular service, but only to show that practical experience is as necessary as technical knowledge when economy is in the offing.

Indian Creek, Pa. P. N. E.

Ways of Eliminating Vibration In Electric Motors

VIBRATION is a common cause of failure of electrical machinery, particularly motors. Its elimination is, therefore, of prime importance if such apparatus is to be kept in first class running condition.

Motor Speeds for Ordinary Spur Gear Drives

Hp. Rating	Maximum	Best
1	1200	900
2	1200	900
5	900	900
7½	900	720
10	900	720
15	720	600
20	720	600
30	720	600
50	600	600
75	600	514
100	600	514
150	514	450
200	450	450

Vibration should have prompt attention when once discovered.

Vibration may be due to one or more of the following causes: (1) Unsteady foundation; (2) gearing at too high a speed; (3) unbalanced armature or rotor; (4) sprung or bent shaft; (5) large bore or loose bearings; (6) poor alignment and leveling; (7) defective coupling.

Trouble due to an unsteady foundation can usually be detected by inspecting the base carefully. Most of the other causes are not so simply detected, and it is not an easy matter to state just what is causing a machine to vibrate without checking up the possible causes and locating the trouble by elimination.

The most destructive kind of vibration is not a shake that can be seen, but a fine sharp buzz that can best be detected with the finger tips. Such a vibration is produced by gearing at too high a speed for a given size motor or poorly meshed gearing at appropriate speeds. Mechanical unbalance in armature, rotor or pulley will also cause this type of vibration. What is commonly called crystallization often results and leads to connections breaking loose, rotor bars breaking in two, and even the breaking of frames and bearing supports.

To prevent vibration by gearing, the motor speeds for a given horsepower, as shown in the table, should not be exceeded. This refers to plain spur gearing. Considerably higher speeds are permissible if a flexible coupling is interposed between the motor and the first pinion, or if herring bone gearing or silent chain drive is used. With belting also, from 1½ to 2 times the speed allowable for gearing is permissible. Therefore, if a motor with a speed higher than that given in the table is encountered and is giving trouble from vibration, the remedy is to change the type of drive to any of those mentioned above.

If the armature or rotor of a machine is not properly balanced, considerable vibration will result. The spiders of large machines are usually cast with grooves in which to place the lead for balancing. On smaller machines it will be found necessary to resort to some other means of storing the lead. One method is to drill and tap the spider so that the lead may be fastened with a machine screw.

If no balancing rails are available, a "running balance" may be obtained as follows: Select a small piece of lead and wedge it into the grooves, or otherwise secure it in place. Try the machine at no load and at various stages up to full load. If the vibration is practically the same, try heavier pieces until some change is noted. By changing the amount and location of the weight the vibration can be practically eliminated, if the trouble is due to unbalance.

A sprung shaft will cause vibration, the amount depending on how much the shaft is bent. The vibration will usually be localized in one of the bearings and for this reason the cause may be difficult to distinguish from several others. To check an armature or rotor for a bent shaft the best method is to place it in a lathe. A rough check may, however, be made with the armature or rotor in place, by the following method: Arrange a movable support for a lead pencil and gradually move it toward the shaft at a point as far from the bearing as possible. As soon as the pencil has made light contact with the shaft, stop the machine and examine the shaft carefully. If the mark extends all the way around shaft the latter is, in all probability, straight. If the mark

does not extend all the way around the shaft, several checks should be made at different points on the shaft. If these all give the same results the armature or rotor will have to be removed from the machine to be straightened.

The whipping about of a journal in its bearing, and sometimes of a bearing in its housing, is a fruitful source of vibration. If the bore of the bearing has become worn and is too large for the shaft, it will have to be rebabbitted or replaced.

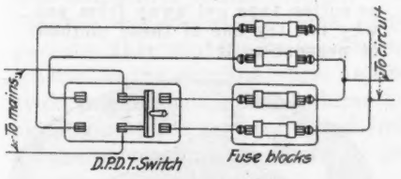
Where the two units of a coupled set are not in good alignment, there is bound to be some vibration. A shaft that is not level will also cause vibration. The remedy in both cases is obvious.

A longitudinal, or to and fro, motion of an armature or rotor is usually caused by a coupling which is incorrectly drilled for the coupling pins. The holes for these pins should be accurately spaced and at the same distance from the coupling center. In addition to this, the holes should be drilled at right angles to the coupling face. If a coupling is bored to fit a larger size shaft, considerable care must be exercised to get the bore exactly at a right angle to the coupling face; otherwise serious trouble from vibration will soon develop. FREDERICK KRUG.

Comerio Falls,
Bayamon, Porto Rico.

How to Restore Service Quickly after Fuse Blows

AN ARRANGEMENT which makes it possible to restore the power in a circuit immediately when a fuse blows is shown in the accompanying diagram. This is a very simple yet useful application to any circuit where time of outage means money. The only alterations necessary to the ordinary circuit are to change the present switch in use



When a fuse blows the switch is thrown in the opposite direction to restore power to the circuit.

to a double-pole, double-throw switch and add an extra fuse and block.

Of course, if there is a short circuit or other trouble in the circuit the second fuse will blow out. The trouble must then be located and removed, but for ordinary blowouts, by throwing the switch in the opposite direction the plant will immediately have power again for working purposes and the blown fuse may be replaced for further emergency. DONALD L. HOARE.

New York, N. Y.

Motor Failures Caused by Loose Oil-Switch Blade

A NUMBER of 150-hp. motors in a New England cotton mill burned out with no apparent cause, shutting down important departments and causing much trouble and expense. An inspection disclosed the fact that one of the blades of an oil switch feeding the motor circuit had slipped down on the pull-rod. On closing the switch poor contact was first made but it carried sufficient current to start the motors satisfactorily. Subsequent vibration, however, caused the blade to open, thereby bringing about single-phase operation of the motors. As they were fairly well loaded they became overheated when running single-phase and finally burned out.

Boston, Mass. H. S. KNOWLTON.

Some Causes of Oil Leaks in Bearings and Their Prevention

ONE OF the first steps in stopping the leakage of oil at the bearings of machines, is to find the cause. A study of a number of cases shows that they usually are the result of some one of the following causes: (a) A porous bearing; (b) oil gage joints not properly sealed; (c) bearing end-plates not properly sealed; (d) oil too high in the bearings; (e) shafts not level; (f) eccentric oil rings. It is generally easy to check over these causes and see which is at fault in any particular instance.

Trouble due to porous castings and improperly sealed joints at the oil gage or bearing end-plates may be corrected by the application of a mixture of red lead and glycerine made up into a thin paste. Before applying this paste it is best to thoroughly clean the parts affected with carbon tetrachloride, to remove all traces of oil. After applying this thin paste of red lead and glycerine the connections should be made as tight as possible and then allowed to set for two or three hours before oil is again put into the bearings.

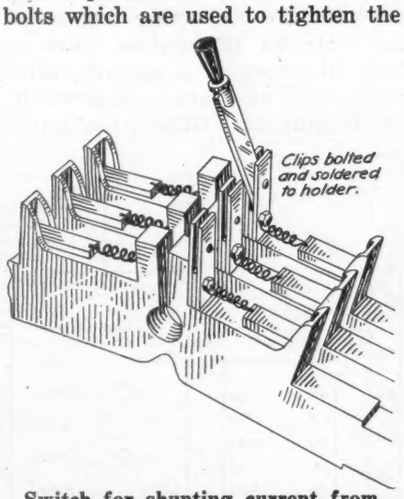
If there is still a leak at the gage after an attempt to correct it by tightening the sight, it shows that the cork washer is probably defective or the gage glass cracked. Creeping of oil along the shaft may be due to too much oil in the bearings or to a shaft that is not level. Occasionally it is also caused by loose or broken babbitt in the bearing houses. It is well to correct either of these difficulties immediately as each may cause more serious trouble. An eccentric oil ring will sometimes spatter oil on the underside of the bearing cover and allow oil to seep through to the outside of the bearing. The remedy for this is to put in a new oil ring, or straighten the old one. FREDERICK KRUG.

Comerio Falls,
Bayamon, Porto Rico.

Short-Circuiting Switch to Relieve Controller while Motor is Running

A SHORT-CIRCUITING switch which we have used on the secondary of type C Crocker-Wheeler motors and found to be very satisfactory is shown in the accompanying drawing. When the motor is running this switch is closed. It shunts all current from the controller and also permits repairs on controller while the motor is running.

This device consists of a knife switch and two clips which are mounted on the brush-holder arm. The clips are fastened under the bolts which are used to tighten the

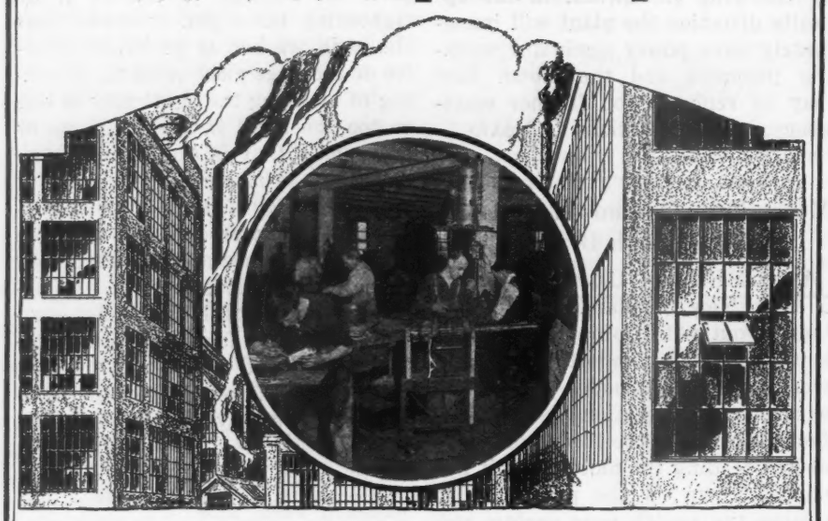


Switch for shunting current from starting controller.

brush holder on the supporting arm and, in addition, are soldered to the brush holder. J. H. SAUVE.

Temiskaming, Que., Can.

In the Repair Shop

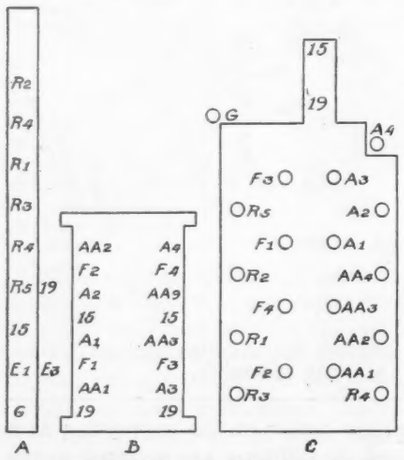


This section is devoted to all sorts of electrical repair work, large and small. Special attention is given to tools found convenient at the shop bench and short cuts or improved methods. Articles on these subjects are always welcome.

Marked Templets for Ringing Out Car Controllers After Overhauling

AFTER an electric car controller has been overhauled it is customary to ring out the connections between the power fingers, reverse fingers, cut-out switches and conconnected are plainly marked, or if any of the internal wiring has been disturbed in course of overhauling. If all points to which the wires are connected are plainly marked, or if the overhauler is thoroughly familiar with the connecting scheme of the controller in question, there is little likelihood of a mistake being made when due care is observed in the ringing out. Where the markings have, however, become unreadable through repeated shellacking or where a number of the repairmen are new to the business, marked templets have been found very useful to the controller overhaulers in the electric repair shop of the Brooklyn Rapid Transit Company. These templets are made of 1/16-in. sheet fiber. The templets shown in the accompanying illustration are used for ringing out the connections of a K-28B controller. Before installing the cylinders, templet *A* is laid alongside of the power finger-board; *B* is dropped into the space between the reverse finger boards, and *C*, the holes and notches in which register exactly with the connecting board posts, is so placed over the connecting board that the posts come up through the holes. As the templets are plainly marked it is an easy matter to ring between all connections of the same markings and thereby determine that every post or finger is connected to every other post or finger to which it should be connected. Once it is correctly laid out and marked, a templet serves virtually as a most simple form of controller wiring diagram.

J. A. HORTON.
Brooklyn, N. Y.



These templets are placed in or on the controller when ringing out the connections.

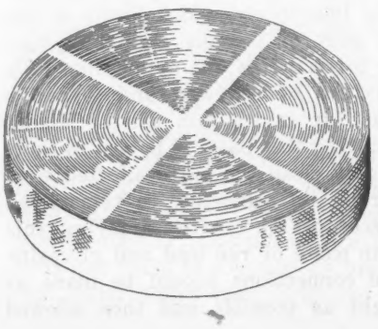
Two Methods of Making Rolls of Cotton Tape More Easily Handled

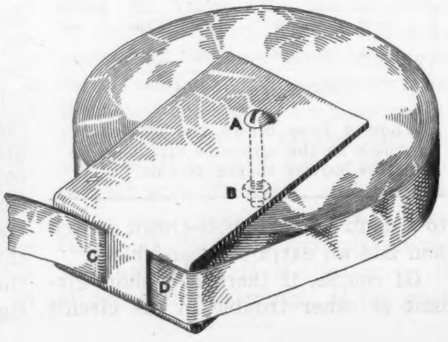
PROBABLY every electrician has experienced the exasperating circumstances of having a roll of cotton or linen tape slip out of his hand and unroll across the floor, necessitating him getting down from an awkward position, as on a transformer, to re-roll it. Such mishaps as this might make even Practical Pete lose his smile. To prevent this, repairmen will find either of the following methods which I have used satisfactory.

The first method is to stripe two thin cross-lines of glue across one side of the roll, as shown in the accompanying sketch at the left, and similar crossed lines on the other side of the roll with the cross rotated 45 deg. Only a small amount of glue is required for this and it may be applied with a small brush or even with a stick or the finger. This keeps the tape from unrolling too easily, although it does not interfere with its use.

Another method is to use a tape holder, as shown at the right in the accompanying sketch. This holder can easily be made as indicated out of 1/16-in. brass or copper. A different holder must be made for each size of tape used. The tension on the tape may be varied by tightening or loosening the screw *A* in the brass nut *B*, which is soldered to the opposite side of the holder. The two slits *C* and *D* are made the width of the holder and about ¾ in. apart.

If you have ever had a roll of linen or cotton tape get away from you, why not try one of these methods of preventing it?



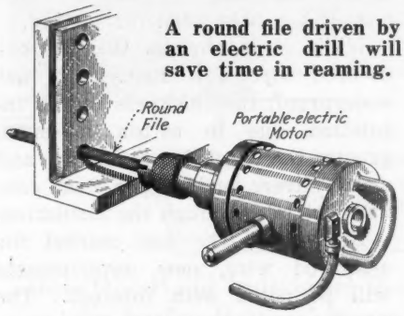


The tape should be torn at the edge of the holder and not at *C*.

San Francisco, Calif. S. H. SAMUELS.

Motor-Driven File Lessens Work Of Reaming Small Holes

A HAND REAMER to take off burrs and sharp edges and to make the required clearances for entering shafts, bolts and rivets can be made with a file and a portable motor or an electric drill. Ordinarily these various clearances are



A round file driven by an electric drill will save time in reaming.

made with chisels, punches, hand reamers and files, but a round file driven at a good speed by a portable motor will accomplish a variety of work with a considerable saving of time over the other methods.

Sheet-metal parts, from the springy nature of the material, often overlap the holes for retaining screws or interfere with the assembly of other pieces. Such parts often require file work or chiseling. The improvised hand reamer, with its rapidly revolving file, will save much time on such work.

Washington, D. C. G. A. LUERS.

Armature Banding Machine Made from Old Lathe

IN A REPAIR SHOP where many direct-current armatures are repaired, some trouble was experienced in the banding operations, and several armatures failed because the banding was improperly done. Apparently this was due to insufficient tension in the banding wire, and to avoid possible additional failures an old engine lathe was converted into a banding machine, as shown in the accompanying illustration.

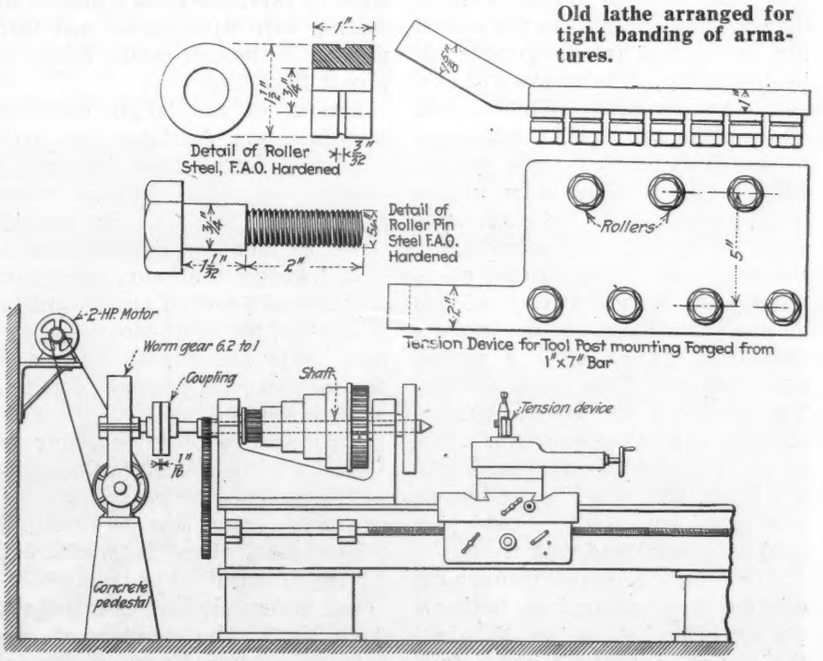
The lathe was so badly worn that accurate machine work could not be done with it and orders had been given to scrap it. It was noticed that the spindle was hollow; so a piece of shaft was turned down, the finished diameter being very slightly smaller than the hole in the spindle. The face-plate end was turned with a taper to fit the taper bore of the spindle after which the center was rough turned and hardened. The shaft was placed inside the spindle and after being lightly tapped into place a shaft collar was put on at the outer end to hold it in place. The center was then finished by grinding with a tool-post grinder. The worm-gear drive unit, having a ratio of about 6 to 1, was placed in position on a concrete pedestal as shown. The flange coupling was placed on the shaft ends and lined up, leaving 1/16 in. between the coupling faces. Normally the couplings are bolted together by 2-in. x 5/8-in. turned bolts, a 1/16-in. fiber sheet fitting between the coupling faces. The worm gear is driven by a 2-hp., 950 r. p. m. direct-current motor, the speed being controlled by a hand-operated rheostat.

Armatures to be banded are handled in the usual way except that the lathe dog used fits in the face-plate slots tightly. The worm gear, being self-locking, always holds the band wire under tension while it is being soldered.

The old-fashioned fiber-block clamp which was used as a tension device was replaced by the tension device of which the details are shown. The 1 5/8-in. x 2-in. shank fits into the tool post of this lathe, the band wire being zig-zagged back and forth over the rollers as many times as may be necessary to produce the desired tension. By means of the change gears, set to cut from ten to sixteen threads per inch, the banding wire is fed on to the armature with perfect regularity and at a uniform tension.

When necessary to use the lathe to turn or slot commutators, the bolts and fiber spacer are removed from the flange couplings, allowing the lathe to be driven through the cone pulley, as is usual. The general principle of the tension device was brought to the shop by a machinist who had made a similar device to hold a uniform tension on spring wire while winding springs of 1/8-in. diameter wire in a lathe. The whole arrangement is most satisfactory in every particular.

Bonne Terre, Mo. H. R. WASS.



Old lathe arranged for tight banding of armatures.

The Invention and Development of Enameled Wire

THE FIRST commercial baked enameled wire of record was apparently invented by John H. Vinton for use in connection with shoe machinery, and not for electrical purposes. Mr. Vinton's U. S. Pats. Nos. 662,247 and 662,248, Nov. 20, 1900, disclose a product and a process, respectively, which was subsequently applied to electric conductors. In these patents it is claimed that the product may be bent into small articles without stripping, cracking, or breaking off the coating, and that the wire may be safely used with automatic machinery.

This process consists in passing the bare wire through a liquid or varnish having the consistency of

water, and then baking in an oven at a temperature of about 550° F. If the temperature is too great "the life is taken out of the coating and the latter is reduced to a powdered form, which is readily brushed or stripped off the wire." The liquid is composed of copal gum, linseed oil and turpentine. Bone-black may be added. From the bath the wire passes over a wick before entering the oven.

It may be generally stated that for making enameled wire, oxidizing varnishes of the character just described consist of a base and a solvent. The base consists of some form of vegetable oil, as linseed oil, castor oil, and so forth, and a hard resin, as copal gum (or sometimes an asphaltic compound) to give the film a dense body. Solvents consist of turpentine, kerosene and other similar materials. Unlike a wood-protecting varnish, the oxidation of the oils and gums is retarded as much as possible until the varnish-coated wire enters the enameling oven, when the oxidation takes place very rapidly. The film is a partially carbonized residuum of the materials contained in the varnish. The materials used in the base do not dry out at ordinary temperatures. Hence, the temperature must be kept constant at a value found by experiment. Drafts of air in the ovens tend to make the product uneven.

In U. S. Patents Nos. 806,574-7, Dec. 5, 1905, just expired, George H. Rupley describes an insulated wire and three processes, wherein the residuum constituting the enamel film is obtained from vegetable oils by distillation. The presence of oxygen is not required. While linseed oil gave the best results, cottonseed oil and even corn oil were successfully employed. The color of the coating produced on the wire varies from brown to black, according to the thickness. Raw linseed oil is mixed with 2 per cent each of oxid of zinc and litharge and the mixture thoroughly boiled until a partial saponification of the oil is effected. The glycerids are broken up and glycerin and other elements of the oil which prevent the film hardening are driven off. Rosin oil or turpentine is added after the oxids are completely combined with the oil.

After the wire passes through the solution it enters an oven having a temperature of about 500° F., where the solvent is volatized and a fractional distillation of the hydrocarbons produced from the oil by the preliminary treatment is effected. The film thus produced is a hardened coating of residues of fatty acids, or a residuum of destructively-distilled vegetable oil.

Of the two general processes described above, the latter is more rapid and is cheaper.

Charles P. Steinmetz appears to be the originator of the first structureless-cellulose coated wire. In U. S. Patent No. 669,358, March 5, 1901, he was granted the broad claim: "A bare wire covered with a film of structureless cellulose." Cotton wool was dissolved in an ammoniacal solution of cupric oxid. After passing the wire through the solution and allowing it to dry it was passed through diluted hydrochloric acid, washed with pure water, and dried. Further improvements along this general line were developed principally by Elihu Thomson and John J. Callan.

Early attempts, of historical interest only, are mentioned below. In U. S. Patent No. 58,217, Sept. 25, 1866, James J. Clark and Henry Splitdorf claimed the following: "Making helices for electro-magnetic and magneto-electric machines from wire insulated by passing it through any powdered material, such as powdered glass, stone, sand, or paper-pulp, after the wire has been passed through any sticky fluid, and before the sticky fluid becomes dry." H. Redding, U. S. Patent No. 189,262, April 3, 1877, describes a process of coating wire with shellac and then passing it through candle flames to give it flexibility.

Several of the larger electrical manufacturers developed the wire-enameling art without taking out patents. Therefore, little is known as to whom credit is due besides those mentioned. Furthermore, it is not known that any suits were ever brought against any alleged infringers of the above-mentioned patents. After the varnish is baked on the wire there is no way of telling what was in the varnish.

Enameling wire is becoming an old art. Wire-enamel varnishes, as well as machines for producing enameled wire, may now be obtained. Nevertheless, there is much room for improvement. For instance, the film is not waterproof, as it contains "pinholes." The number of pinholes in a given length is used as one standard of judging the quality of the film. One way to detect pinholes is to run the enameled wire slowly through a mercury bath with voltage impressed between the conducting core and the mercury, and with a voltmeter or other indicator in series. A voltmeter having a resistance of 100 ohms per volt will not only show the number of pinholes in a given length, but will indicate the insulation resistance according to well-known principles. While some enameled-wire manufacturers do not advocate the mercury-bath test, it has been used for testing.

While it is obvious that cotton-covered wire, for instance, is not waterproof, the thickness of the insulation due to cotton is much greater than that due to enamel, and metal slivers and copper dust cannot protrude through the insulation.

Because of the vast market for enameled wire, new developments will be noted with interest. The present tendency appears to be along the lines of production by passing the wire through the ovens at high speeds and increasing the oven temperatures. With the production of a waterproof enameled wire, coil impregnation should be quite unnecessary, excepting to fill up the interstices between turns and thus facilitate the cooling of the coil. However, the invention of enameled wire has increased the efficiency, decreased the size, and generally lowered the cost of electromagnetic devices in which it now replaces cotton- and silk-covered wire. Several enameled-wire manufacturers claim a dielectric strength of 600 volts per mil for their product.

Combinations of enamel and single-cotton, and enamel and single-silk have displaced the more bulky double textile coverings in many cases, and have still left the required electrical and mechanical properties. In this connection, it is interesting to note that Henry Splitdorf, a noted manufacturer of magnet wire in his time, patented under date of Dec. 14, 1875, U. S. Patent No. 171,185, a "mode of constructing insulated wire by first coating the wire directly with shellac or other non-conducting gummy material, then winding silk or other thread on the wire, and finally heating the whole to unite the gummy coating and thread."

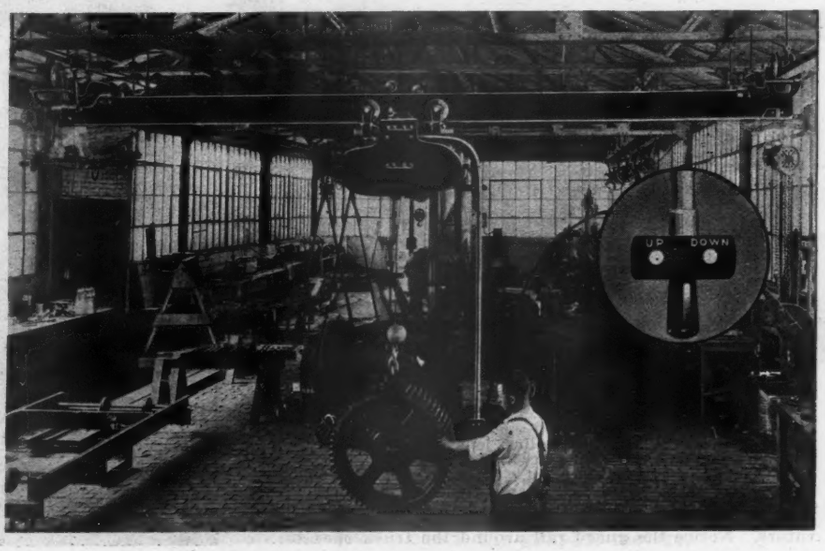
CHARLES R. UNDERHILL.
Consulting Engineer,
White Plains, N. Y.

Better ways to transport and handle raw and finished parts in and around the works will be discussed in this section.

How One-Hand Individual Hoists Reduce Production Costs by Saving Helpers' Wages and Speeding the Work

SOME types of industrial work may easily be performed by one man except for short intermittent periods when he requires the aid of a helper, such as for lifting work on and off machines, holding work during fitting and assembly, turning work over, and similar tasks. Even with the best of planning this helper is idle frequently and if he serves several men will occasionally necessitate one or more of them waiting on him. The same condition exists in many plants where a number of men or groups of men rely on a few large cranes or hoists to serve all of them. These types of work offer many opportunities for small hoists and other material-handling equipment.

One company, for example, installed over 50 light-weight hoists on trolleys, as shown in the accompanying illustration, as auxiliary equipment to supplement the work of two heavy cranes, so that each group of men could have a hoist as they needed it and not have to wait. The hoist pictured here (The Cleveland Crane & Engineering Company, Wickliffe, Ohio) is a one-hand push-button control hoist where all the motions of handling the hoist are performed by one hand, thus leaving the other free to perform other work. A close study of many kinds of intermittent labor will often indicate a means whereby one man and some mechanical device can do the work, instead of gangs of helpers. Mechanical devices can usually do this work so much more economically that even though they may be idle at short times, the idleness is not as expensive as that of large gangs of men. Besides saving the services and wages of helpers, which are easily measured, individual hoist installations usually give additional, and less easily measured, economies through increasing production by eliminating waiting time and visiting time as well as increasing the speed when making the lift.



A type of one-man push button control hoist on a monorail trolley which is often used to replace helpers in miscellaneous shop work.

One Hours' Work of an Electric Lift Truck in an Industrial Plant

ONE OF the most difficult points when considering the installation of modern material-handling equipment is to visualize what it will actually do. One method of doing this is to see the work actually done in a typical installation. If, for example, the solution of a trucking problem is considered, some idea of what a truck will do would be obtained by following the work performed by a truck in another plant.

Trucking may be roughly divided into two classes: (1) Hauling in which the same kind of material is carried over a specific route, as coal from yard to bunkers and (2) general miscellaneous factory hauling—the movement of anything to and from anywhere within the buildings or yard. It is this second class of work which is the most difficult to visualize.

For much of this general hauling it is best to use platforms or skids, particularly if the work is to be moved from machine to machine or department to department. With the skids, the work may be left on the platform and replaced after it is finished and so eliminate the obvious rehandling. The entire platform can be lifted up by an electric or hand-lift truck and moved as quickly whether it contains one unit or several thousands on the platform or box skid.

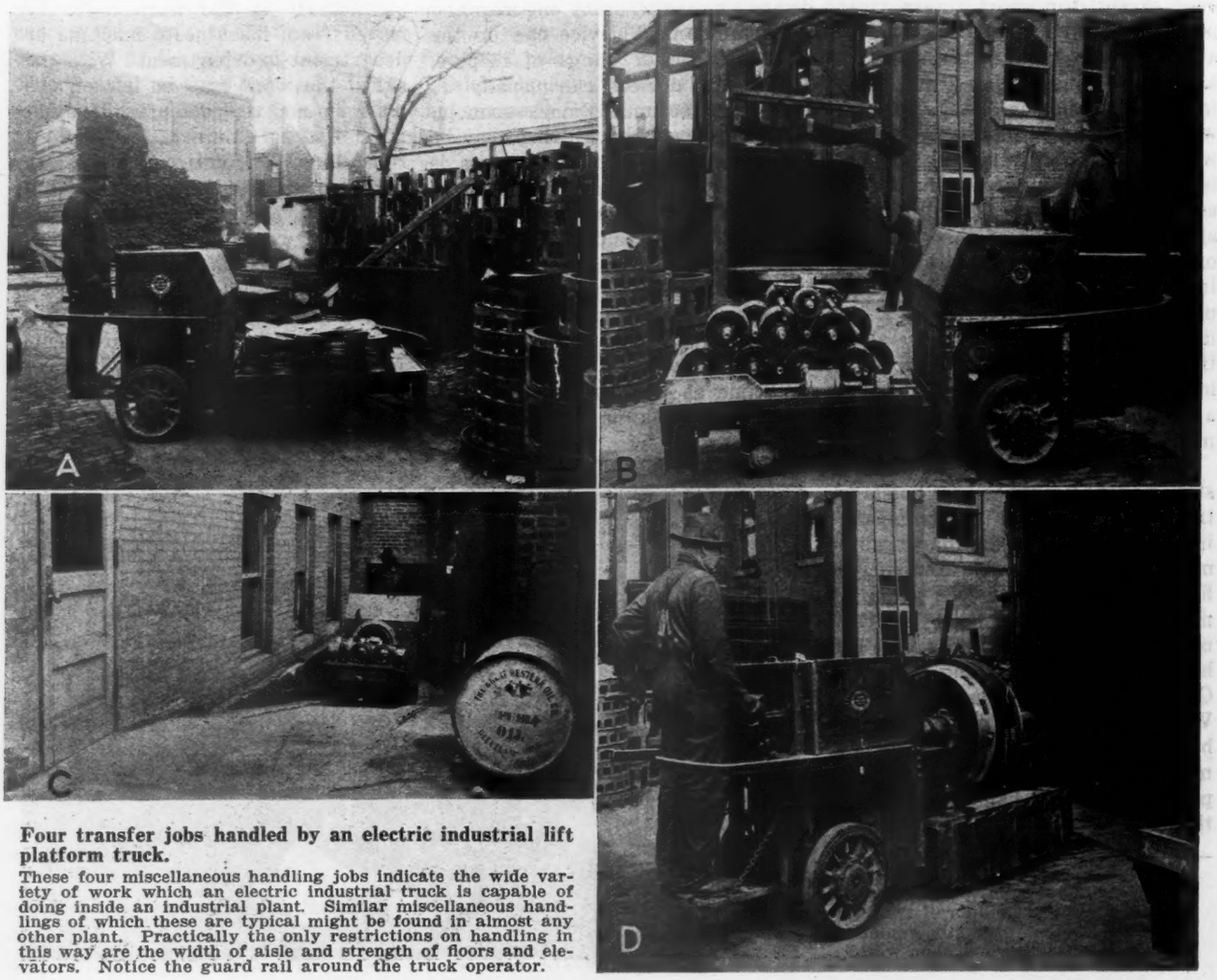
As it would occupy too much space to list all of the trucking movements in a day's work, this item will cover only one hour's activities in the Cleveland, Ohio, plant of The Lin-

coln Electric Company. These operations, however, are not special but typical of a regular daily performance. In this an electric elevating platform lift truck (The Elwell-Parker Electric Company, Cleveland, Ohio) is used with platform or skid to conserve the time of the truck when loading and unloading. One hour's work was as follows:

Starting at 9 o'clock in the morning, four loads of punched laminations, *A*, were carried on the truck from the punching department in the basement to the storeroom, a distance of approximately 200 ft. The truck then proceeded to stockroom No. 1 where three loads of rotors, *B*, were taken to the general assembly room in the main building. The next job on hand was to transfer three loads of wound frames, *C*, from the insulating dip oven to the assembly floor in the main building. The next task found to do was to carry a stacked rotor from the machine shop down an incline to the basement and then by elevator up to the third floor for winding, *D*. These eleven hauls completed the hour. These jobs were not a "set-up" but in each case after the trucker had completed one group of operations he had to find his next load, carry it to its destination and then seek the next, and so on. It is conservatively estimated by the superintendent in charge that it would have required at least ten men with hand-trucks to do the work now being done by this one electric truck. Even then it would be practically impossible for them to handle some of the larger castings and frames at all.

Although this hour's work is typical, some of the other tasks handled are of interest. For example, in the course of a day this truck is called upon to bring rough castings from the storage yard to the machine shop, to deliver wire and copper to assembling floor, to take completed motors to storeroom or shipping department as the occasion requires, and, in fact, handle any parts that are used in the manufacture of the motors as they are taken through the various departments and operations. The weight and the size of the loads in this miscellaneous work vary considerably but the average load will weigh between 1,500 and 2,000 lb.

One especially interesting operation of this truck is work on a 15-deg. incline, as shown at *C* in the accompanying illustration. These inclines are located between the basement and the first and second floors. To enable the truck to operate in wet weather it was necessary to cover the incline with a wire mesh. The truck is also fitted with side rails which extend around the operator, as is shown in the accompanying illustrations, and not only protect him from injury in case he should accidentally back into a wall, but also automatically open swinging doors of the different departments as the truck approaches. The truck is equipped with twelve-cell, fifteen-plate Ironclad Exide batteries. One charge, which costs approximately 25 cents, keeps the truck operating all day except where the work is unusually heavy or during bad weather. Under these unusual conditions a boosting charge is given at noon.



Four transfer jobs handled by an electric industrial lift platform truck.

These four miscellaneous handling jobs indicate the wide variety of work which an electric industrial truck is capable of doing inside an industrial plant. Similar miscellaneous handlings of which these are typical might be found in almost any other plant. Practically the only restrictions on handling in this way are the width of aisle and strength of floors and elevators. Notice the guard rail around the truck operator.

Ways of Mounting Small Motors

(*Continued from page 593*)

The same size of motor drives the screw machine (shown at the right) and this is mounted on 1¾-in. by ¼-in. strap iron carried by two 2-in. by ¼-in. straps at right-angles, the latter being attached to a bracket of 1½-in. by 1½-in. by 3/16-in. angles. Flexible armored conductor fits admirably into the wiring arrangements in cases like this where turns have to be made in going to the motor and to the control switch or box.

Another example of exterior driving from above is seen in *B* of Fig. 3, which also shows an inside-mounted motor in service. In the first case, the framing required to support the shaft bearings of a duplex drill (shown at the left) was also utilized as a base for mounting a 1-hp. motor at the top of the tool, the motor being mounted on ½-in. by 1½-in. U-shaped straps bolted into the tool frame. The operator does not have to step out of position to manipulate the starting switch. The lathe at the right is driven by a ¾-hp. motor mounted within the frame on a base formed by the cross-bracing between the upright end supports. Both of these motors are mounted so as to occupy no space otherwise useful in the shop.

Underslinging the motor for a small drill-press is shown in *B* of Fig. 4. A quarter-turn belt drive was required in this case. Strap-iron supports ⅜ in. thick and ⅞ in. wide proved sufficient to carry the ½-hp. motor used, and the wiring problem was simplified by the location of both motor and starting box close to the column outlet from which the unit is supplied with energy.

Fig. 2 shows three bench applications of motor drives. In these cases portability often is a factor of importance; or else maximum ease of starting and stopping is required. At *A* is a motor-driven screw-and-bolt driver. The reversing switch on top of the motor provides for the most rapid handling of this light work, and rigid conduit feed effectively protects the operator and the wiring. A portable polishing motor is shown in *B* with detachable clamp straps for bench service. Ruggedness is not sacrificed to portability. The simplicity with which a small motor of the coil-winding type can be mounted on a right-angled wooden base and attached to a bench is shown in *C*. These small motors fit into bench work in a way that is little appreciated in many shops, and should be more widely used.

From a closer study of these views it will be seen that there are excellent opportunities to economize on material as well as in space in utilizing small integral and fractional-horsepower motors for individual drives in repair shops. Short runs of wire, well protected by rigid or flexible conduit and control switches located as close to the motor as the needs of the tool operator allow, all spell minimum cost of installation. The amount of motor driving that can thus be put into either an old or a new shop without interfering with aisle space is surprising. The mechanical requirements of such short drives should, of course, receive due attention in planning motor locations.

Fig. 5—Engine lathe drive with belted motor showing protected motor switch mounted above the chuck.

Graphic Meter as a Watch Dog

(*Continued from page 584*)

changed somewhat and the process may be regulated by observing the variations from the normal load.

An approximate check of the load only may be obtained with an alternating-current ammeter due to the fact that the power factor of an induction motor decreases rapidly below three-fourths full load; thus the current at no load will often be equal to half the current at full load. However, the current peaks above the rating of the motor may be watched and where the strength of the mechanical drive is known, the point where the mechanism would be broken may be avoided. The current as shown by a direct-current ammeter is of course directly proportional to the power input to the motor. The direct-current chart on page 584 shows the wide variations of load even with good operation while the chart from the alternating-current ammeter shows only a minor current variation.

A sufficient number of indicating instruments should be used in addition to one recording meter in order that the operator may check the performance of the equipment from the various locations where the work may require his presence. The indicating meters also should be used to check the graphic meters.

Armature and Field Defects

(*Continued from page 578*)

or sparking and a change of voltage in a generator is found with a variation in load, the trouble may be due to incorrect setting of the brushes or to poor adjustment of the interpole winding.

The position of the brushes should be tested first. Probably the best way to set brushes on a commutating-pole machine is to run it as a series motor, using the armature and commutating poles only, the main field coils being entirely disconnected. When the brushes are set so that the flux is divided equally on both sides, the motor will not rotate and there will be no torque tending to produce rotation. An armature resistance will have to be used to keep the current down to about twice full-load current. When the brushes are just about in the right place, the amount of torque may be so small that it will not actually produce rotation, but the torque can be felt by turning the pulley around by hand, noticing whether or not it turns harder in one direction than the other. The brushes must be so accurately set that there is no torque in either direction when twice full-load current is flowing through the armature and commutating poles.

After the brushes are correctly set if the trouble still exists the interpole is not properly adjusted and the manufacturer of the machine should be consulted.

(10.) Unequal Air Gaps and (11) Worn Bearings.—These troubles will be treated together because the effect of worn bearings is to produce unequal air gaps. Fig. 5 shows a four-pole machine in which the bearings have worn sufficiently to make the air gaps much smaller at the lower than the upper pole piece. This results in an increase in the magnetic flux in the bottom air gap and a decrease in upper air gap. This produces a higher voltage in the coils in the lower half of the armature.

In a wave-wound machine the effect is neutralized as the windings pass under both poles from coil to coil, but it may produce poor commutation at the brushes.

In a lap winding the trouble is more serious and may result in the lower half of the armature carrying all of the load or in extreme cases the difference may be sufficient to reverse the current in the upper half of the armature. Under these conditions the upper half of a generator will be operating as a motor receiving its current from the lower half, or in a motor the upper half may be operating as a generator driven by the lower half.

Unequal air gaps may be caused at other pole pieces by a variation in length of the pole pieces, poor centering of bearings or bearing pedestals or by belt pull. It is well to give air gaps careful and frequent attention.

12. Flux Distribution.—It is not within the province of this series of articles to discuss flux distribution in detail. Poor flux distribution will cause sparking, commutator heating and armature heating. Poor flux distribution is caused by unequal air gaps, weak fields which do not keep the pole pieces magnetically saturated, or by defective field windings, all of which have been treated under other headings in this series.

Charles Proteus Steinmetz

(*Continued from page 596*)

introduction of alternating current apparatus.

"Steinmetz's practical inventions literally cover the entire field of electrical applications: Generators, motors, transformers, lightning arresters, lighting, heating and electrochemical operations. Of these many inventions, which were set forth in some 200 patents, perhaps the most important are the induction regulator, the method of phase transformation, as from two phase to three phase, and the metallic-electrode arc lamp. His experimental work in arc lighting led to the production of the magnetic arc. He devoted much time to the development of the mercury arc and by his masterly methods did much to improve this interesting and important type of illumination.

"Steinmetz was an ardent believer in the value of education. He not only found time to aid the educational work of Schenectady, but became president of the National Association of Corporation Schools, and lecturer at Union College. In a masterly address, upon retiring as president of the A. I. E. E. in 1902, he stated that all future progress in science and engineering depends upon the young generation, and to insure unbroken advance it is of pre-eminent importance that the coming generation enter the field properly fitted for the work. His personal example, his spoken words, and his writings have had a powerful and beneficial influence upon the development of the congenial environment and support necessary for a genius like his to develop to the fullest benefit of mankind.

"He was the author of many scientific papers and of a large number of electrical books which have been the accepted standards in colleges, laboratories and workshops everywhere."

* * * *

Charles Proteus Steinmetz, chief consulting engineer of General Electric Company, who died Oct. 26, was born April 9, 1865, at Breslau, Germany. He was educated at the University of Breslau, where he studied mathematics and astronomy, then physics and chemistry, and finally, for a short time, medicine and national economy. In 1889 he came to America, and secured a position with the Osterheld & Eichmeyer Manufacturing Company, Yonkers, N. Y., first as draftsman, then as electrical engineer and designer and finally on research work in charge of the Eichmeyer laboratory.

With the absorption of the Eichmeyer-Field interest by the General Electric Company, Dr. Steinmetz joined the latter and was attached to H. F. Parshall's calculating department in Lynn, Mass. With the transfer of the company's headquarters to Schenectady in the spring of 1894, Dr. Steinmetz organized and took charge of the calculation and design of the company's apparatus and of the research and development work.

For a number of years Dr. Steinmetz was professor of electrical engineering at Union College, and at the time of his death was professor of electro-physics at this institution, at the same time retaining his connection with the General Electric Company as chief consulting engineer, and about the year 1910 again entered into closer relation with this company by organizing a consulting engineering department under his charge.

In 1902, Dr. Steinmetz received the honorary A. M. degree from Harvard University and in 1903 the honorary Ph.D. degree from Union College. He was past president of

the National Association of Corporation Schools, vice president of the International Association of Municipal Electricians, past president of the American Institute of Electrical Engineers, honorary member of the National Electric Light Association, past president of the Illuminating Engineering Society, fellow of the American Association for the Advancement of Science, member of the (British) Institution of Electrical Engineers, member of the American Mathematical Society, the Quaternion Society, the Society of Mechanical Engineers, the Electrochemical Society, the Illuminating Engineering Society, the Physical Society, and others. He was president of the Common Council and twice president of the Board of Education of the city of Schenectady.

Dr. Steinmetz was internationally known for his remarkable engineering achievements and original thinking on scientific subjects. Engineers everywhere have paid tribute to him as a man, a scientist and an engineer during his life time and since his death.

B. G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company, revealed the human side of this man, not so commonly known, in the following statement after his death.

"As a personal friend, I knew him to be a witty, sociable man, and quite human in his dealings with his fellow men. The public, to which he was known as a man of mystery, would have found, as I did in personal contact, a real human being. Unlike many brilliant engineers, he left a record of his work in his numerous writings so that his contributions to science will live. He was a prolific writer on diversified subjects and his keen mind was no more clearly displayed anywhere than in his contributions to scientific journals."

Practical Books

For Your Personal Library

Every man who aspires to larger responsibilities should build up a professional library. Copies of these books may be obtained from the publishers mentioned.

Aluminum Repairing—By Wm. H. H. Platt. Published by The Van Nostrand Company, 8 Warren Street, New York City, 70 pages illustrated, price $1.50.

This book takes up the repairing of aluminum sheet and castings and the attaching of copper, brass or steel to aluminum by tinning, sweating, and burning processes, by the use of sheet-iron jigs. Numerous illustrations with ample explanations show the methods to be adopted in working these processes. Those having occasion to make repairs or do construction work in aluminum will find this book a great help.

* * * *

Lighting Circuits and Switches—By Terrell Croft. Published by McGraw-Hill Book Company, 370 Seventh Avenue, New York City, 472 pages, 557 illustrations, price $3.

A practical reference book relating to electric lighting circuits and switches for interior building and industrial applications operating on low potential (less than 600 volts) systems. Most of the matter deals with 110-220 volt, two-wire and three-wire systems. The principal rules of the National Electrical Code which concerns the subjects under discussion, are interpreted as well as an explanation of how to comply with them.

The simpler circuits are explained and described in the book, but its most important function is to show diagrams and give descriptions of the more complicated circuits and control methods. These are the methods with which relatively few men are familiar and which are in any case easily forgotten. The work consists largely of diagrams and drawings which it has been endeavored to make self-explanatory. A closing chapter discusses circuits and gives complete specifications for the electric lighting of a modern theatre.

* * * *

Belt Conveyors and Belt Elevators—By Frederic V. Hetzel, member A. S. M. E. Published by John Wiley & Sons, Inc., New York City, 333 pages, 291 illustrations, price $5.

Men who have material to handle and who want to know more of the "how" and "why" of conveying and elevating machinery than is told in catalogs and advertisements of manufacturers, as well as engineers and draftsmen who have to advise in the selection or design of conveying or elevating equipment will find this book invaluable. In this book the whole field of handling materials with all its ramifications is not covered, but the use of belt conveyors and belt elevators for handling bulk or loose materials is treated exhaustively. Numerous examples are given of operating conditions which are used to illustrate the general principles underlying the design and use of conveying and elevating machinery. The whole subject is based on thirty years' experience in the designing and supervision of the erection and operation of this type of equipment. The auxiliary or accessory equipment of belt conveyors and elevators, such as belts, pulleys, idlers, chains, discharging and loading devices, in fact practically every phase of the subject is treated thoroughly.

* * * *

Stores and Materials Control — By Madison Cartmell, consulting industrial engineer. Published by The Ronald Press Company, 20 Vesey Street, New York City, 459 pages, price, $4.50.

Effective control of any industrial or commercial organization is usually based upon the control of the material handled. This covers the initiation of the order for the purchase or manufacture for stores, storekeeping, the issuing and filling of requisitions, including their delivery to the different divisions, and the final shipment of the product. This book explains in detail the procedure to be followed in an effective system of materials control in both large and small organizations and the basic principles and generally the practices applied to both alike.

A series of forms has been included which show plainly the steps in the necessary procedure and their interrelation. These illustrate both simple and complicated systems of material control operating under special conditions and so assist either the large or the small plant in applying these principles. A discussion is given on the physical handling and arrangement of materials as well as records which make possible adequate knowledge of location, quantity, and disposition.

* * * *

Economics of Electrical Distribution—By P. O. Reyneau, assistant electrical engineer, The Detroit Edison Company, and H. P. Seelye, distribution engineering department, The Detroit Edison Company. Published by McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City. First edition 205 pages, price $2.50.

The purpose of the book is to present the need for the application of economic principles to the design of distribution systems, to explain the fundamental principles involved, to indicate the type of problems most often encountered and to offer methods of studying such problems and reaching their solution. Practically all of this book is devoted to a theoretical discussion of the problems of electrical distribution and their practical application, although one chapter is devoted to mentioning some of the problems incidental to distribution in industrial plants.

* * * *

The Chemical Resistance of Engineering Materials—By Marston Lovell Hamlin and Francis Mills Turner, Jr. Published by The Chemical Catalog Company, Inc., 19 East 24th Street, New York, N. Y., 259 pages, illustrated, price $5.

Engineers and designers of chemical and other plants wherein acids, alkalis and corrosive liquids in general are handled, have frequent need of definite information regarding the effect of these liquids on the construction materials employed. Heretofore, the information has been scattered through various technical publications and hand- and text-books so that it was not readily accessible for reference. The authors have, therefore, performed a

useful service in collecting together such information as is available in the literature. The aim of the book is: (a) to print the results of experiments and of general knowledge; (b) to serve as a bibliography of the subject by referring to all the sources used; (c) to stimulate further research by showing what parts of the field are incompletely covered.

Following the introduction in Chapter I, covering the general plan of work, classes of material, destructive reactions, and so on, Chapter II discusses sulphuric acid and its action on the various metals and alloys. Other chapter headings are: Other acids and metals; acids and non-metallic materials; bases and alkaline salts; neutral substances; selection of materials for specific equipment; concrete in chemical construction. The last chapter is an appendix containing a large number of useful tables, definitions, names and composition of alloys, physical properties of materials and so on.

Trade Literature
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of the bulletin or catalog desired, as given in these columns.

Minneapolis Electric and Construction Company, Minneapolis, Minn.—A folder describes a wire reel and meter for reeling and measuring wire and cordage of various sizes.

Torchweld Equipment Company, Fulton and Carpenter Streets, Chicago, Ill.—A new 40-page catalog, 23, describes this company's line of oxy-acetylene non-flash welding and cutting apparatus, lead welding, soldering, brazing and decarbonizing units, gas pressure regulators, automatic machines, generators, and other supplies. Cross-sectional views show the operation of both cutting and welding torches.

The Esterline-Angus Company, Indianapolis, Ind. — Bulletin 1023 entitled "Answers to Some Every Day Questions," contains five typical questions which might be asked in any industrial plant, with their answers. One of these questions, for example, is: "How can we tell how much it costs to overcome the friction load in our plant?" The other four are as interesting.

W. A. Jones Foundry and Machine Company, 4401-51 West Roosevelt Road, Chicago, Ill.—Catalog L-28 devotes 56 pages to data on "Lemley" friction clutches. In addition, price lists, dimensions, illustrations, horsepower ratings and other important data are given on sleeve clutches, cut-out couplings, clutch pulleys, ball-bearing clutch pulleys and gas engine clutch pulleys.

Midwest Steel and Supply Company, Inc., 28 West Forty-fourth Street, New York City.—A data book describes the use of "Midwest" steel sections for overhead shafting layouts and also for the anchorage of pipes, cables, machinery, monorails, car tracks, and various other equipment. This comprises a steel section which is embedded in the concrete ceiling, sidewalls or floor at the time of the construction of the building and serves to facilitate the erection of shafthangers, countershafts and other equipment.

The O. A. Olson Manufacturing Company, 706 Wilson Avenue, Ames, Iowa—Circulars describe the Ames lettering instruments used in lettering drawings.

The Autocall Company, Shelby, Ohio—A folder describes various types of Autocall equipment which is used for paging service, industrial fire alarm service, watchman's supervisory service, and in combinations of these.

Mercury Manufacturing Company, 4118 South Halsted Street, Chicago, Ill.—Bulletin 106 on "The Trackless Train" describes the Mercury Type H tractor. This tractor has an internal gear drive instead of a worm drive as has been used on previous models. This is claimed to give an increase of 25 to 35 per cent in efficiency. The power plant—the motor and driving gear—is assembled in a single unit which may be detached from the frame in five minutes.

Holophane Glass Company, 342 Madison Avenue, New York City — Bulletin 34-A entitled "The Holophane Lightmeter," gives a description of this instrument and instructions for its use in the measurement of foot-candles, lamberts, candles per square inch, candle power, coefficient of reflection, transmission factors, and for color matching.

The Leather Belting Exchange, 417-418 Forrest Building, 119 South Fourth Street, Philadelphia, Pa.—A 22-page booklet entitled "Making Leather Belts Endless," discusses in twelve chapters the steps in cementing the ends of leather belts. The points taken up are a discussion of the tools, making the laps, a study of the belts, and applying the cement. The material in this booklet has been published in INDUSTRIAL ENGINEER in the "Service Around the Works" Department but is placed here in a handy and convenient form for reference.

Reinforced Switch and Manufacturing Company, Inc., 400 North Avenue, Pittsburgh, Pa.—A folder describes "The Clip with a Grip," which is a reinforced clip for cartridge and knife-blade type fuses.

Link-Belt Company, Chicago, Ill.—"Silent Chain Data Book 125" discusses the design and construction of chains and wheels, gives instructions and tables for selecting, installing and lubricating drives, with numerous illustrations of drives in various lines of work in several industries. In addition a discussion is given of the use of silent chain and the advantages claimed for it over belts or gears.

Allan Manufacturing and Welding Company, Inc., Buffalo, N. Y. — A folder entitled "Electric Welding with Allan Polyphase," describes the use of alternating-current arc welders constructed for any primary voltage and number of cycles and making use of especially constructed transformers. A table gives the various types manufactured and the particular field to which each is adapted.

The Midland Dynamo and Motor Repairs Company. Ltd., Volta Works, 664 Belgrade Gate, Leicester, Eng.—A 16-page booklet describes the "Quickway" coil-forming machine and illustrates the various types of coils which may be formed on it.

Western Electro-Mechanical Company, Inc., Oakland, Calif.—A booklet entitled "Load Testing Device for A. C. and D. C. Circuits" describes and illustrates commercial testing devices for making electrical tests and measurements, phantom loads, load surveys, coils and windings and meter repairs.

The Formica Insulation Company, Spring Grove Avenue, Cincinnati, Ohio—A reprint of an article entitled "Study of Materials and Methods Needed in Non-Metallic Gear Production," gives a description of the use of Formica and special precautions to be taken when working it up.

The Cutter Company, 1819 Hamilton Street, Philadelphia, Pa.—A folder describes the I-T-E synchronism actuated lock-out feature for use in connection with starting and running switches for synchronous rotaries, to the end that the switch may be passed into the running position only when the rotary which it controls is in approximate synchronism with the system to which it is connected.

The Johns-Pratt Company, Hartford, Conn.—A booklet describes the "Noark" service box which is used as both a cutout and a switch, in one device. Also a number of conduit fittings for watertight service boxes are illustrated and described.

Lockwood, Eslick and Pfohl, Ellicott Square, Buffalo, N. Y. — A 4-page folder describes "Gardco" which is claimed to be an anticorrosive solution which prevents the rusting or corroding of iron, steel and zinc. It has the appearance of an enamel or paint and is claimed to resist the action of acid, fumes and brine and will not blister under heat. It is not affected by moisture, dampness, salt air, spray or sea water and has good electrical insulation properties. A number of suggested applications are included.

Jones, MacNeal and Camp, Inc., Warsaw, Ind. — A folder describes the "Power King" bench or post drill stand which gives the service of a portable drill and drill press from the "Power King" portable electric drill.

Stow Manufacturing Company, Inc., Binghamton, N. Y.—Leaflets G-3 and G-4 describe the Stow motor-driven grinders, buffers, drills and die-sinking tools. These are a portable, adjustable type of machine designed for a wide variety of work.

RECEIVED DEC

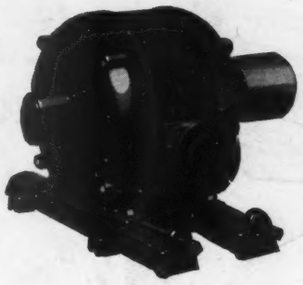
INDUSTRIAL ENGINEER

Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories

Founded 1882 as the Electrical Review

December, 1923

McGraw-Hill Co., Inc. Chicago, Ill.



Thoughts of the waning year bring to us a deep sense of obligation to those whose confidence we have tried to merit

We wish you a

Merry Christmas

and a

Happy New Year

Howell Electric Motors Company
Howell, Michigan

Howell RED BAND ELECTRIC Motors

Make Good On The Hard Jobs

UNIVERSITY OF MINNESOTA ELECTRICAL ENGINEERING LIBRARY

MOTORS

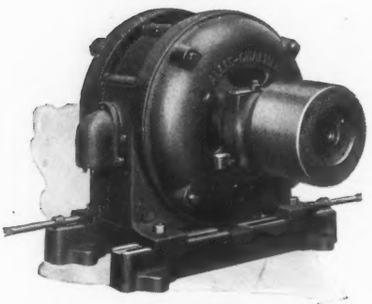
DIRECT AND ALTERNATING CURRENT

Type "E" Motor

Allis-Chalmers Induction Motors

Type "AR" Constant Speed

Type "ARY" Variable Speed of Correct Design and Rugged Construction



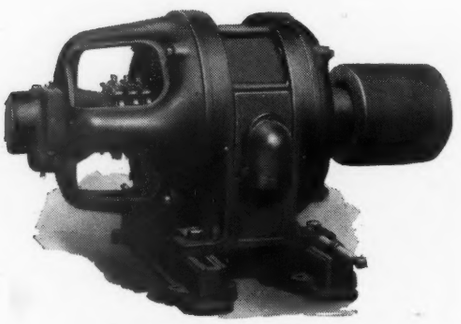
Type "AR" Motor

Allis-Chalmers Type "E" Direct Current Motors

Built for *Service.*

Constant or Adjustable Speed Ratings

For Belting or Direct Connection



Type "ARY" Motor

Send for Bulletins

ALLIS-CHALMERS PRODUCTS
Electrical Machinery
Steam Turbines
Steam Engines
Gas and Oil Engines
Hydraulic Turbines
Crushing and Cement Machinery
Mining Machinery

ALLIS-CHALMERS MANUFACTURING COMPANY

MILWAUKEE, WISCONSIN, U.S.A.

District Offices in All Leading Cities.

ALLIS-CHALMERS PRODUCTS
Flour and Saw Mill Machinery
Power Transmission Machinery
Pumping Engines-Centrifugal Pumps
Steam and Electric Hoists
Air Compressors - Air Brakes
Agricultural Machinery
Condensers

Contents for December, 1923

INDUSTRIAL ENGINEER

Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories

Founded in 1882 as Electrical Review with which was consolidated Western Electrician

D. H. BRAYMER, *Editorial Director*

Volume 81. *Number 12*

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A Glimpse Into the Works of the Endicott-Johnson Corporation 568

How One Factory Has Benefited by Revamping An Obsolete Lighting System 571

J. J. McLaughlin Shows Results Obtained in Plant of Williamson Wire Novelty Company, Newark, N. J., by Replacing Drop Cord Lighting with Bare Lamps by Gas-Filled Lamps in Efficient Reflectors.

Troubles Caused by Armature and Field Defects 575

This Is the Fourth of a Series of Articles by E. H. Martindale in Which Are Discussed Causes and Remedies for Various Brush and Commutator Troubles.

Troubles Charged to Installation and Operation of Flexible Couplings 579

In this Article, Which Is the Third of a Series, Possible Sources of Trouble in Operation often Attributed to Flexible Couplings, as Well as Considerations to Be Observed When Installing Them, Are Discussed.

A Graphic Meter as a Watch Dog Prevents Breakdowns and Costly Repairs 584

J. Elmer Housley Tells How Graphic Ammeters on Motors Driving Stirring Machines in Plant of Aluminum Ore Company Have Prevented Overloads and Breakdowns.

Diagrams and Information on Two- and Four-Speed Windings 585

A. C. Roe in Fourth of a Series of Articles on Connecting Induction Motors Discusses Multi-Speed Windings with Connections for Salient and Consequent Poles.

Some Practical Ways of Mounting Small Motors 591

Describes Methods Used in Boston, Mass., Repair Shops of Western Electric Company for Mounting Small Motors.

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Some Questions We've Been Asked

Are building repairs, improvements and plant safety included in the work of a maintenance organization?—In industrial organizations where plant service and maintenance is well organized the maintenance department includes distinct sub-departments or provides for the employment of men skilled in handling electrical installation and repair work, millwright work, carpenter, painting and masonry work, plumbing, ventilating and heating and machinery moving, trucking and janitor service. Such service the maintenance department is called upon to do in all departments of the works and it may include new additions, changes, inspections, overhauling and repairs so that machines and equipment engaged in production can be operated, with the fewest possible interruptions, at maximum output. The men engaged in production on such machines depend upon the maintenance organization to provide needed attention to their machines, aside from adjustments and setting up of operations, and in cases of trouble the maintenance men are called upon and expected to report in a hurry.

Building repairs, improvements and safety come under the head of plant service and the maintenance of set standards that include the maintenance of the physical condition of equipment and its housing facilities, which depreciate from natural wear and tear of production operations and from age. All of this work falls to the maintenance organization and where a definite organization is not provided, a certain few men are required to perform some or all the duties of the well-organized departments and in this respect these few men must be pretty much "jacks of all trades."

For instance, here is a typical list of jobs that came to the maintenance department of a certain plant in a single day:

Repair faucets and radiator in Building 15; repair two toilets and faucets in Section 3; install new light over timekeeping station; install starting box on power press; install swinging doors in store room; install gas burners in foundry; connect new motors in foundry; replace window panes in chemical laboratory; change wiring on power press motor; repair roof on foundry; install safety device on power press; put new caster on chair for auditor; replace shelves in laboratory; replace pinion gears on punch press motors.

INDUSTRIAL ENGINEER is devoted to the problems of those **men who are responsible** for operating and maintenance service for electrical and associated mechanical systems in mills and factories. And under maintenance is included the upkeep of buildings housing these systems and the standards set up for safety to operators and against fire. It does not deal with the individual problems of maintenance men who are the workmen and helpers, but with the problems of those men **who analyze maintenance procedure and lay out the work** for their assistants.—*Practical Pete.*

McGRAW-HILL COMPANY, INC., OLD COLONY BUILDING, CHICAGO, ILLINOIS
Tenth Ave. at 36th St., New York

JAMES H. McGRAW, President
ARTHUR J. BALDWIN, Vice-President
MALCOLM MUIR, Vice-President
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MASON BRITTON, Vice-President
JAMES H. McGRAW, Jr., Secy. and Treas.

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Engineering News-Record — American Machinist
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Bus Transportation — Electric Railway Journal
Journal of Electricity
(Published in San Francisco)
Industrial Engineer — Electrical Retailing
(Published in Chicago) (Published in Chicago)
American Machinist—European Edition
(Published in London)

The annual subscription is $2 to any part of the United States, Canada, Mexico, Alaska, Hawaii, the Philippines, Porto Rico, Canal Zone, Cuba, Honduras, Nicaragua, Peru, Colombia, Bolivia, Dominican Republic, Panama, El Salvador, Argentina, Brazil, Spain, Uruguay, Costa Rica, Ecuador, Guatemala and Paraguay. Extra postage to other countries, $1 (total $3). Single copy, 25 cents.

Change of Address—When change of address is ordered the new and the old address must be given. Notice must be received at least ten days before the change takes place. Printed in U. S. A. Copyright, 1923, by McGraw-Hill Company, Inc. Published monthly. Entered as second-class matter Nov. 7, 1908, at the Post Office at Chicago, under act of March 3, 1879.

Quartz and slate, from the quarries of Pennsylvania, are necessary ingredients as a filler for certain forms of electrical insulation

Quality Ingredients are Needed for a Quality Product

G-E insulating materials must be of the best in order to insure the dependability of G-E apparatus. To make these insulating materials superior in quality, no effort has been spared. For years the markets of the world have been combed for raw materials, and a capable laboratory staff has weighed, measured and tested every ingredient and every combination. The result is insulation of supreme excellence—worthy of incorporation into G-E apparatus.

The General Electric Company now offers these superior insulations to the world. Any G-E distributor can furnish information, or address

General Electric Company
Merchandise Dept. Bridgeport, Conn.

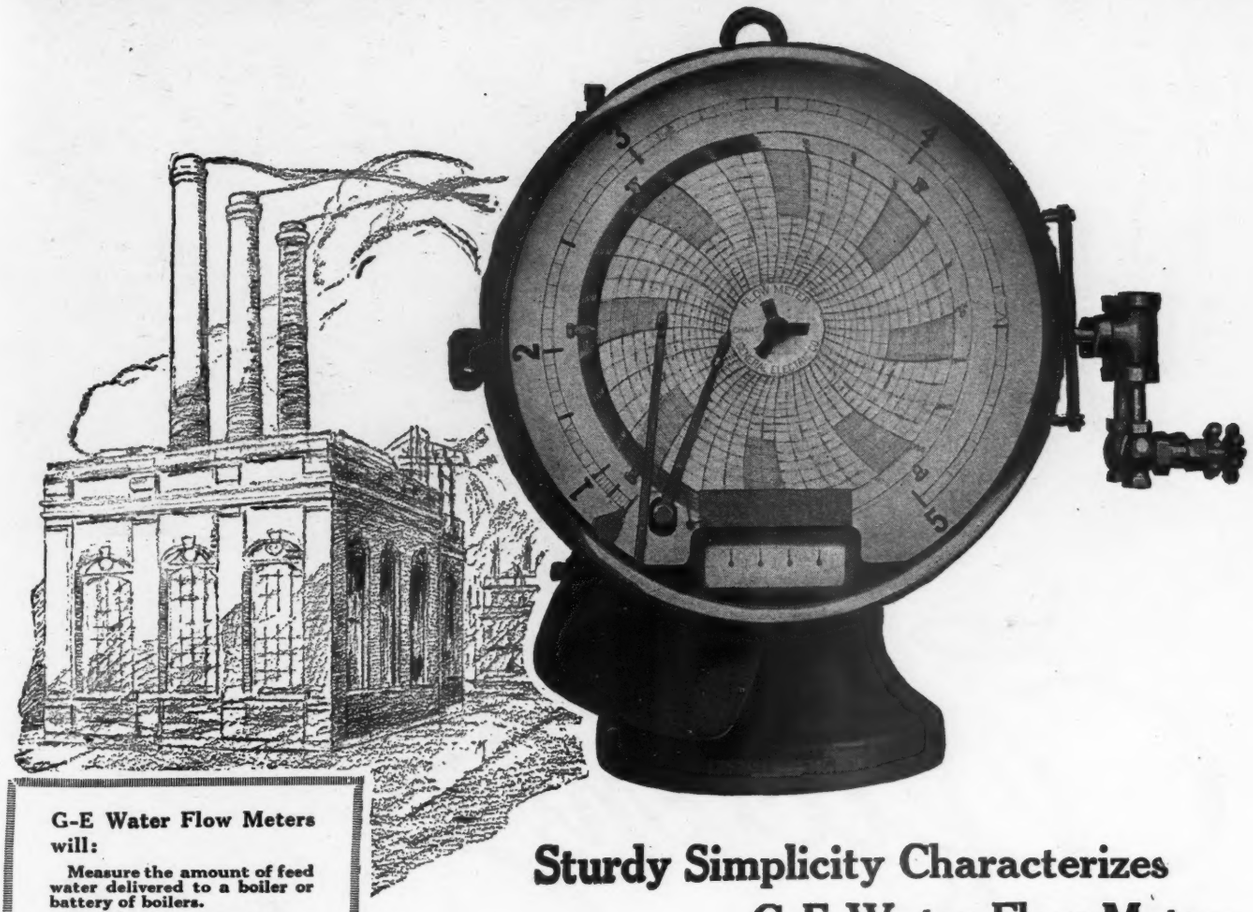
G-E Insulations Include:

- Insulating Varnishes and Oil
- Stickers and Shellacs
- Sealing and Filling Compounds
- Paints for Electrical Apparatus
- Treated Cloths
- Treated Fibres and Paper
- Cords, Twines and Insulating Tapes
- Flexible Varnished Tubing

G-E Insulations

Use them when you build—demand them for repairs

48G-6



G-E Water Flow Meters will:

Measure the amount of feed water delivered to a boiler or battery of boilers.

Measure the output of a pumping plant.

Measure the total amount of water consumed by a municipality, or the amount distributed to different sections.

Measure the water input to water turbines thereby furnishing a means for determining their capacity and efficiency.

Measure the amount of water consumed in manufacturing processes.

Measure the amount of cooling water used in condensers.

Determine the slippage losses in pumps due to leaky plungers or valves.

Discover loss due to leaks in water mains, etc.

Discover sudden fluctuations of flow which would cause dangerous water hammer.

Sturdy Simplicity Characterizes G-E Water Flow Meters

G-E Water Flow Meters are simple in construction, easy to install and will measure satisfactorily the flow of hot or cold water for any purpose.

They register the total flow, indicate and record the rate of flow in pounds per hour, gallons per minute or boiler horsepower. These meters can also be supplied with temperature gauge recording temperature of water on the same chart with the flow.

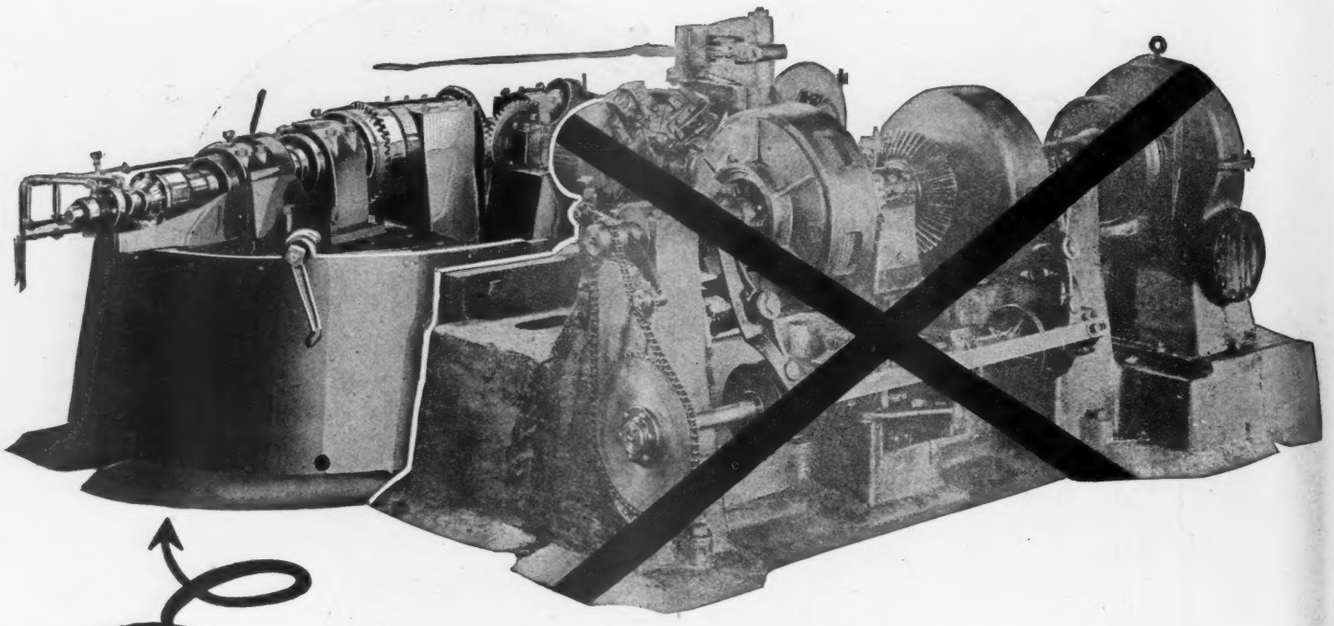
Ask our nearest office for information about these meters.

General Electric Company
General Office, Schenectady, N. Y.
Sales Offices in all Large Cities

G-E Flow Meters
for measuring steam, air, water, etc.

A GENERAL ELECTRIC PRODUCT

34C-65



Efficient Control

The Anderson Rolled Gear Company had too much machinery in its old type of rolled gear machine. The picture above shows how much has been eliminated.

G-E engineers applied suitable control equipment to actuate a G-E direct-connected reversing motor—and the necessary reversing operation of the rolled gear machine became *electrical* instead of mechanical.

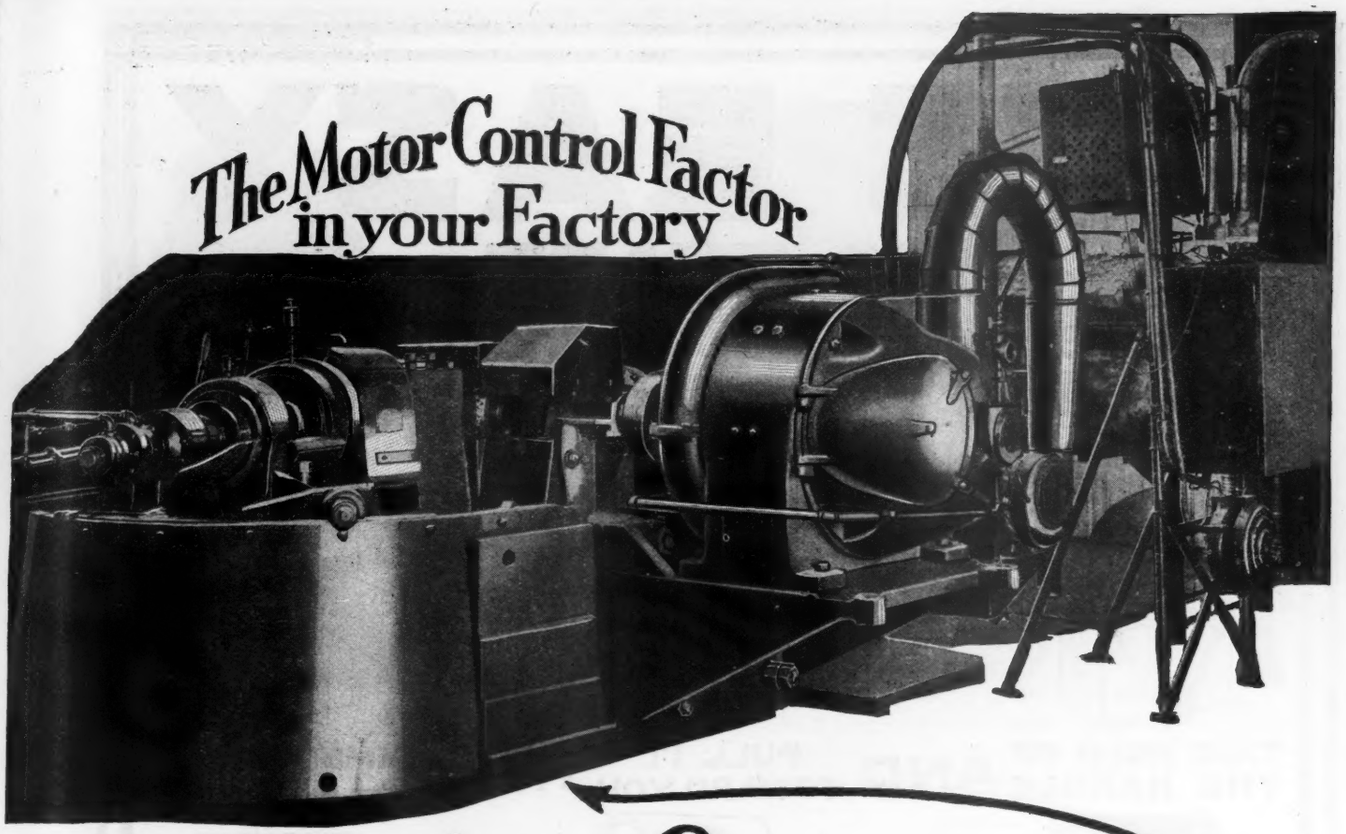
With the complete electric operation of the rolled gear machine, a new gear is formed every 43 seconds. Only 23 seconds are used in rolling the gear, in which time the motor makes over 20 reversals.

The application of G-E equipment to the Anderson

G-E Industrial Control Equipment directs the work of a countless number and a great variety of alternating — and direct-current motor-driven machines in plants the country over.

General Electric Company
Schenectady, N. Y.

GENERAL



The Motor Control Factor in your Factory

Simplifies Machines

Rolled Gear Company's machine secured these advantages:

Expensive, complicated mechanical drive parts of the machine were replaced by less expensive electric operating equipment — at a big net saving.

Cutting off the mechanical drive part of the machine eliminated the maintenance expense of frequent replacement of clutches, gears and bearings — worn by continuous reversing duty.

The application of complete electrical equipment to the machine reduced the power input from 90 Hp. to 9 Hp. — and a 17½ Hp. motor replaced the 125 Hp. motor hitched to the old mechanical drive.

It is worth while to *simplify*. G-E engineers will gladly co-operate with you in improving your machinery by suitable application of electrical equipment.

Broad experience in supplying Industrial Control Equipment for diversified motor applications places the General Electric Company in a position to meet your requirements — readily.

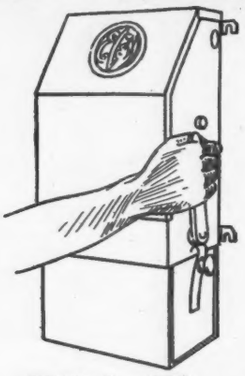
General Electric Company
Sales Offices in all Large Cities

43A-94

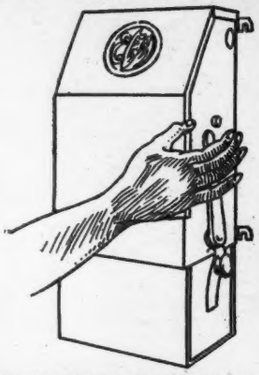
ELECTRIC

IT'S EASY
TO START
THE TYPE ZK MANUAL-AUTOMATIC COMPENSATOR

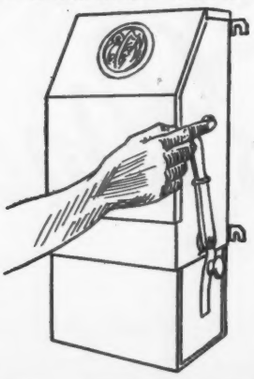
TAKE HOLD OF THE HANDLE

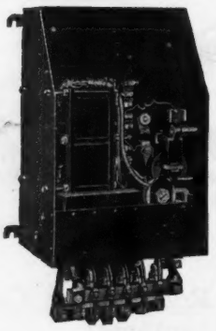


AND PULL IT TOWARD YOU



THEN IMMEDIATELY LET GO





TO STOP
PUSH THE BUTTON

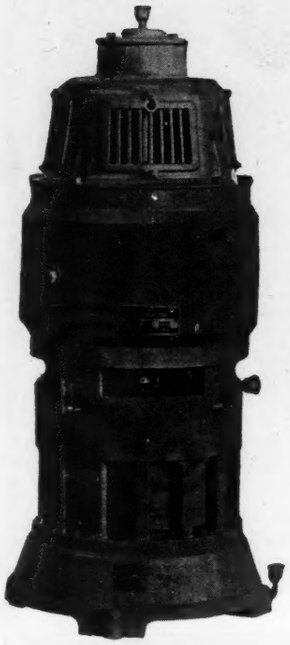
The Type ZK Manual-Automatic Compensator for starting and stopping A. C. Motors is easy to operate. It automatically thinks for the operator who has only to pull the handle to connect the motor through the transformers to the line and start it. Then as soon as the motor has reached the proper speed, the Compensator automatically throws it across the line. To stop the motor it is only necessary to push the button above the handle.

The Compensator provides inverse time element overload protection while starting and while running, and protects the motor against lost phase and no-voltage.

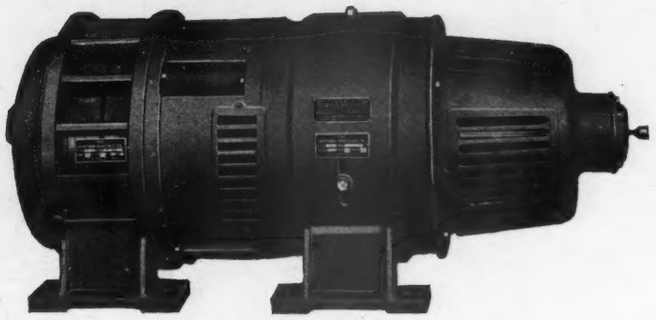
Write for Bulletin 1046

THE ELECTRIC CONTROLLER & MFG. CO.

BIRMINGHAM-BROWN-MARX BLDG.
CHICAGO-CONWAY BLDG.
CINCINNATI-FIFTH NATIONAL BANK BLDG.
DENVER-3535 WALNUT ST.
DETROIT-DIME BANK BLDG.
CLEVELAND, OHIO
LOS ANGELES-O. E. THOMAS CO.
BOSTON-49 FEDERAL ST.
NEW YORK-50 CHURCH ST.
PHILADELPHIA-WITHERSPOON BLDG.
PITTSBURGH-OLIVER BLDG.
SAN FRANCISCO-CALL BUILDING
SEATTLE-524 1ST AVE. SOUTH
TORONTO-TRADERS BANK BLDG.



Vertical Ball Bearing
AC to DC
Motor Generator
Sizes 1 to 10 KW



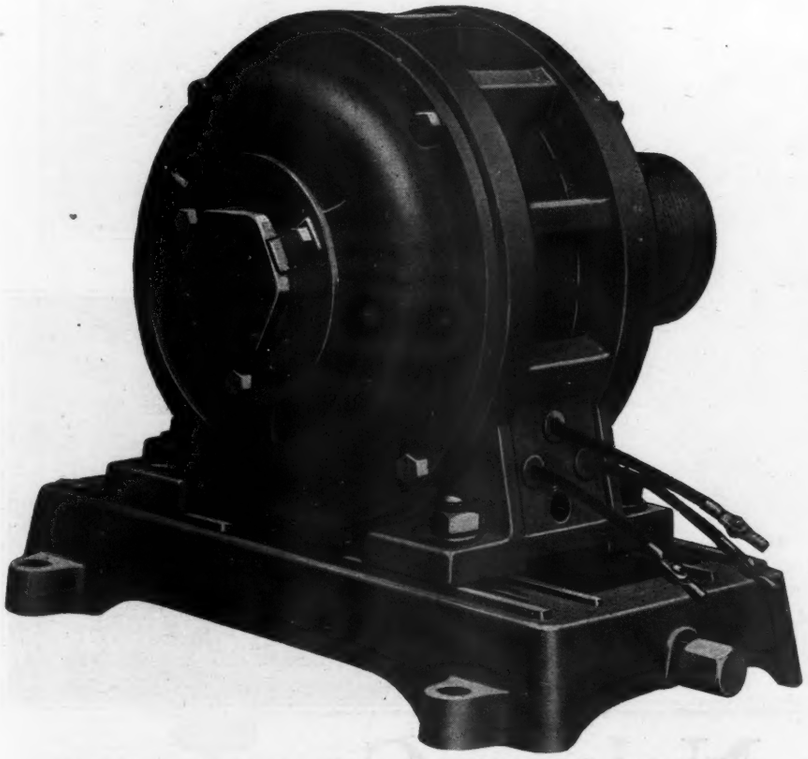
Horizontal Ball Bearing
AC to DC Motor Generator
Sizes 3 to 17 KW

Motor Generators that are built to furnish Direct Current of any volt-ampere characteristic that is most suitable for the service. Built either Horizontal or Vertical and Ball Bearing. Used by such Companies as—

AMERICAN RADIATOR COMPANY
HOLT MANUFACTURING COMPANY
INDUSTRIAL TRUCK COMPANY
BAKER R & L COMPANY

and

Backed by many years experience. Statements that *talk*.



40° Polyphase Induction Motor, Ball Bearing, Size ½ to 50 H. P.

Hertner Induction Motors have many factors that recommend them, such as—

Safety
High Power
Perfect Lubrication
Well Ventilated

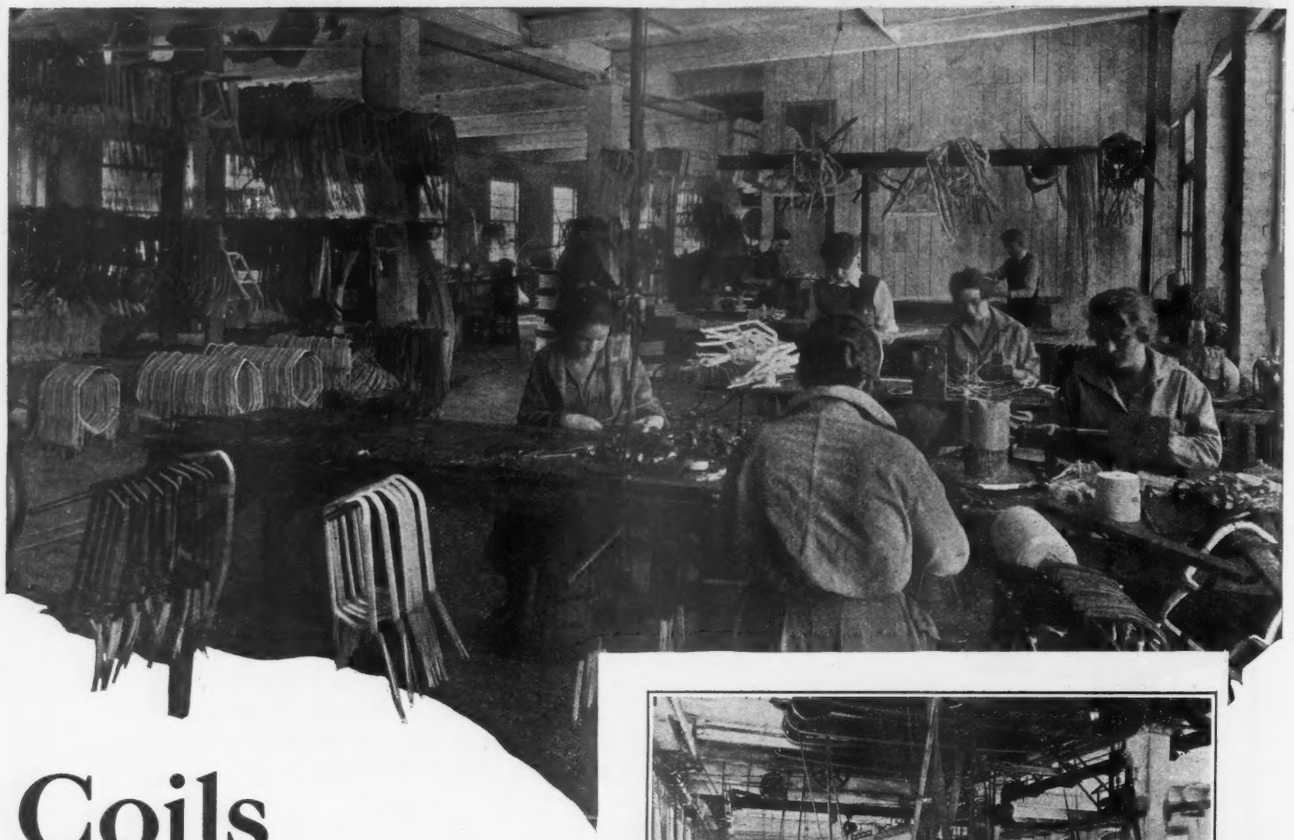
We stand ready to show you why our motors give satisfaction to thousands of users over a period of many years.

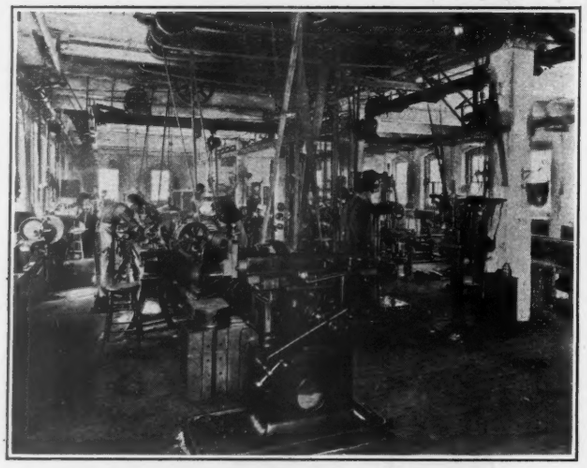
Write for Bulletin 10A.

The Hertner Electric Co.

W. 112th St.
CLEVELAND, OHIO

Rochester, N. Y. Detroit, Mich. Chicago, Ill.
St. Louis, Mo. Rockford, Ill.





Coils
for production

Electrical equipment manufacturers will do well to get sample coils and prices for their products. This company is now turning out thousands of coils weekly on a production basis. It costs nothing to check up. Drop us a line with a blue print or send sample coil.

Coils for maintenance

For years, I. R. Nelson Co. has supplied many of the leading steel, iron, copper, zinc, tin and other metal working industries with new coils for maintenance. Tell us of your requirements.

Service to Industry

Our emergency service will undertake any repair, large or small. A force of from 1 to 10 men can leave Newark within 2 hours after receipt of wire or phone message.

Get in touch with us. We shall be glad to serve you.

I. R. Nelson Co.
Bond Street
Newark, New Jersey

In the Shop

You need good machines and good men in the Shop. Both bring big money. Neither is of any use without good lighting.

Good lighting depends upon good wiring devices. A good wiring device gives uninterrupted service for years and years. A poor wiring device gives trouble.

Even a good wiring device costs only a few cents. A poor wiring device costs a few fractions of a cent less.

Think a moment: when you try to save a few cents on wiring devices that are not as good as Bryant you may be making trouble and expense that runs into thousands of dollars of lost productive time. Where is the saving?

There are two outstanding reasons for the known superiority of Bryant Wiring Devices.

One is: we want to make them better than any others.

The other is: thirty-five years of experience have taught us how to do it.

No. 2597
with Cast Cover

No. 1924

This is one of a series of advertisements depicting the scope of service rendered by Bryant Wiring Devices

BRYANT
SUPERIOR WIRING DEVICES

"A Superior Wiring Device for every Electrical Need"

THE BRYANT ELECTRIC COMPANY
1421 STATE ST., BRIDGEPORT, CONN.

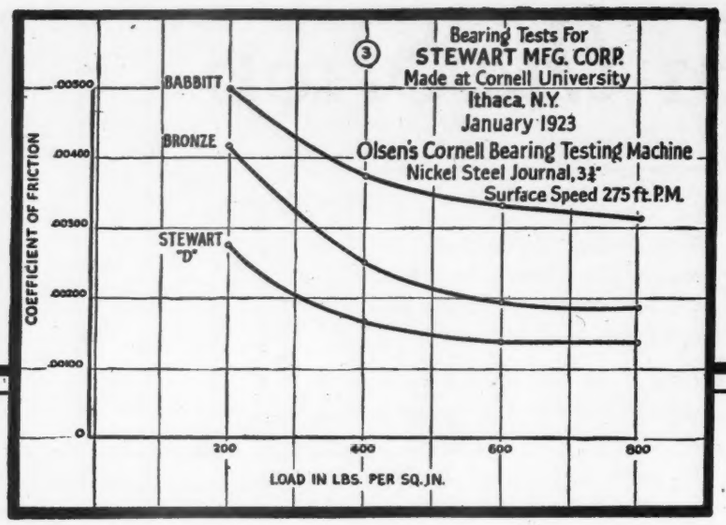
NEW YORK
342 Madison Ave.

CHICAGO
844 West Adams St.

SAN FRANCISCO
149 New Montgomery St.

This chart shows the results up to a pressure of 800 lbs. per sq. in. of a test conducted by Professor W. M. Sawdon, of the College of Engineering of Cornell University.

A high grade mineral oil was used as lubricant, applied to bottom of the shaft. Lubrication and all other conditions were the same for each metal. The bearings were put on, one at a time, and thoroughly worn in. The friction and temperature rise of each metal under each load were noted and plotted. The result was a remarkable demonstration of the bearing quality of Stewart Brons Metal.



Are You Buying Bearing Quality?

Add an inch and save 2

The ordinary bar of bearing metal is 12″ long. Stewart Brons Bar is 13″ long machined all over. That extra inch gives you 12 full inches of bearings with ample room for tool clearance and chucking; saving besides the labor and overhead of machining.

The average saving for every user of Stewart Brons is about 50% of the bearing metal, and a big saving in bearing costs.

LOOK over the plotted result of this remarkable bearing metal test. Made by a disinterested scientist, it is conclusive evidence that Stewart Brons is the *perfect* bearing metal; that Stewart has discovered the long sought secret—the perfect amalgamation of copper and lead in any desired proportion.

Consider what that means, as this competitive test proves, to users of bearing metal! *Now*—with the advent of Stewart Brons—you get the best bearing quality known.

[1] Stewart Brons Provides remarkable bearing quality through an unusually low coefficient of friction.

[2] Its melting point is 1700°F.; remember ordinary babbitt melts at 400°F.

[3] At 600°F. it sweats a little lead and so lubricates itself should lubrication fail.

[4] Will not burn out or score a shaft up to 1000°F.—is uniform in texture; the interfusion of copper and lead makes it homogeneous; the union of the metals become seven closer with successive remeltings.

Stewart Brons Metal is made in four grades: "B" 25 Brinell; "C" 40 Brinell; "D" 50 Brinell; "E" 80 Brinell [a special metal for heavy service]. 258 stock sizes of bars and bushings, 13″ lengths, finished all over.

Our proposal to jobbers is very attractive. Write for details.

STEWART MANUFACTURING CORPORATION
4509-92 Fullerton Avenue Chicago, Illinois

Or communicate with our nearest factory representative

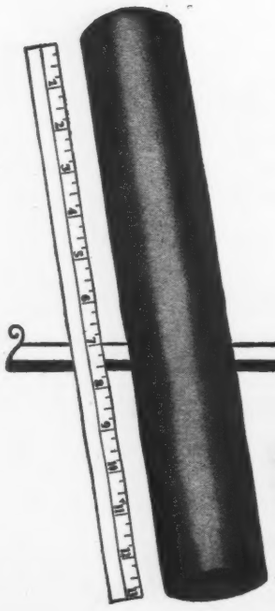
L. RUPRECHT
30 Church Street
New York, N. Y.

A. C. OLFS
7321 Woodward Avenue
Detroit, Mich.

C. W. ROOT
57 Erie Street
Milwaukee, Wis.

J. FRANK LANNING & CO.
327 First Avenue
Pittsburgh, Pa.

E. P. GRISMER
1986 E. 66th Street
Cleveland, Ohio



Stewart Brons Bearing Metal
The Perfect Metal for Bearings

He doesn't sell them to you, he buys them for you

Look on the Western Electric motor dealer in your town as your expert representative, *buying for you.*

He knows motors and has gone over the field with thoroughness before he recommends any type for your use. He studies your needs and equips himself to fill them.

This dealer carries stocks to meet ordinary requirements. For more special demands he can call on a nearby Western Electric House.

A NATIONAL ELECTRICAL SERVICE

Western Electric Company

OFFICES IN ALL PRINCIPAL CITIES

THE ARRO-GRIP CAP

FOR PENDENT SOCKETS ON INDUSTRIAL PENDENT WORK

Another Reason for Standardizing on Arrow Sockets

This wouldn't have happened with ARRO-GRIP

Note the insurance against wire troubles with ARRO-GRIP

A and AA

C

D and DD

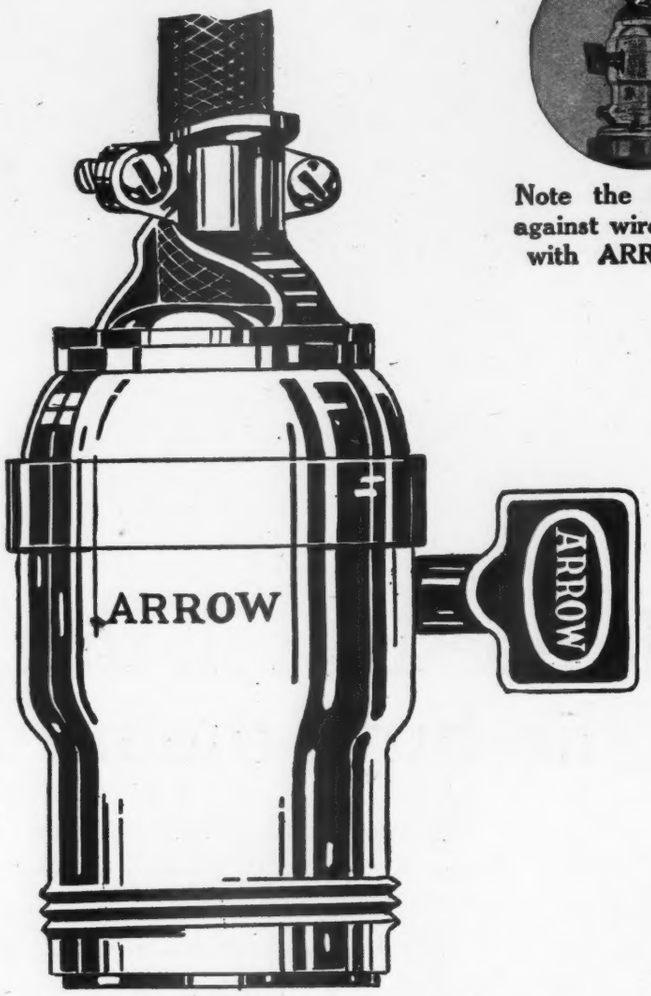
W

R

S

T

F and FF



No. A-62

Any Arrow Socket Body will take No. 62 Arro-Grip Cap. Use Arro-Grip Sockets for industrial pendent work to prevent fraying and pulling away of wires from binding screws.

Send for New Arrow Catalog

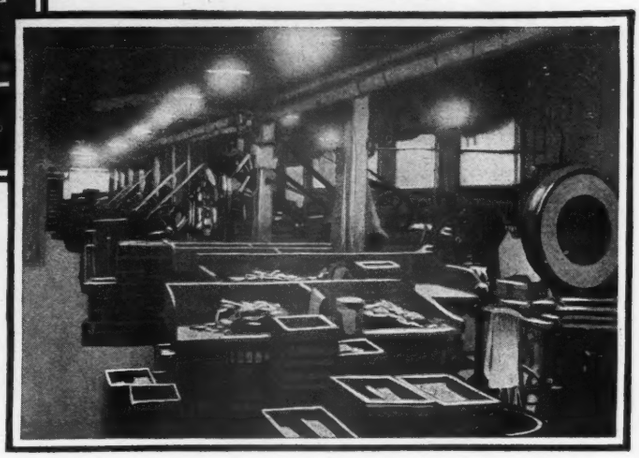
THE ARROW ELECTRIC COMPANY
HARTFORD, CONNECTICUT

ELECTRICAL ARROW WIRING DEVICES

ARROW

The complete line of Wiring Devices

"Before and After" Lighting



Previous to re-lighting, this plant used bare, unshielded lamps of various sizes, scattered at random. In the new installation, bowl enameled MAZDA C Lamps in RLM standard dome reflectors are symmetrically spaced and hung at the correct height. It is quite apparent why production is increased.

THE PICTURES above were taken in a silverware factory. But consider such widely diverse products as breakfast food, men's collars and talking machines.

That lighting is a powerful factor in the efficiency of *any* plant, is shown in these letters — quoted from the many that are received by our Lighting Service Dept.

From The Shredded Wheat Company

Our superintendent reports most gratifying results from the use of your lamps and the lighting systems installed in our Buffalo Ave. and Erie Ave. plants.

The lamps are certainly better for our purpose than any we have formerly used, and there is no doubt that the improved lighting has given us greater production and a more uniform product.

With better lighting there is naturally less spoilage and waste—and less eye-strain; a fact that induces higher efficiency and better morale.

A. J. PORTER, *President*

From The Victor Talking Machine Co.

We have devoted considerable time to the study of lighting, from which we have drawn the following conclusions:

1. Proper lighting is a distinct aid in securing production and has a favorable effect not only on quantity but also on accuracy.
2. Good lighting is perhaps the first thing to be considered in safety work.
3. In sanitation we find that it pays to be liberal with light.
4. Morale of our working force is strengthened by the psychological effect of well-lighted surroundings.

A. W. ATKINSON

From Cluett, Peabody & Co., Inc. ("Arrow Collars")

In order to produce the highest quality of work in the most efficient manner, it is of first importance that illumination be given to all parts of our plants.

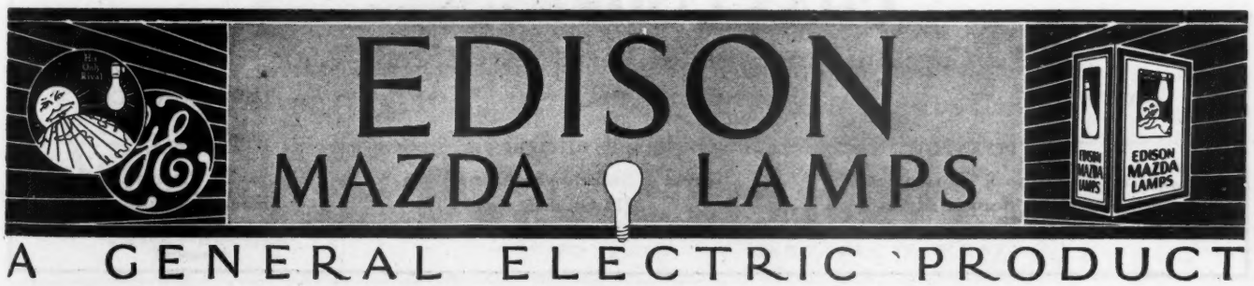
Protection of employees' eyesight, and agreeable and pleasant working conditions, mean that much more light must be supplied than is sufficient merely for safety.

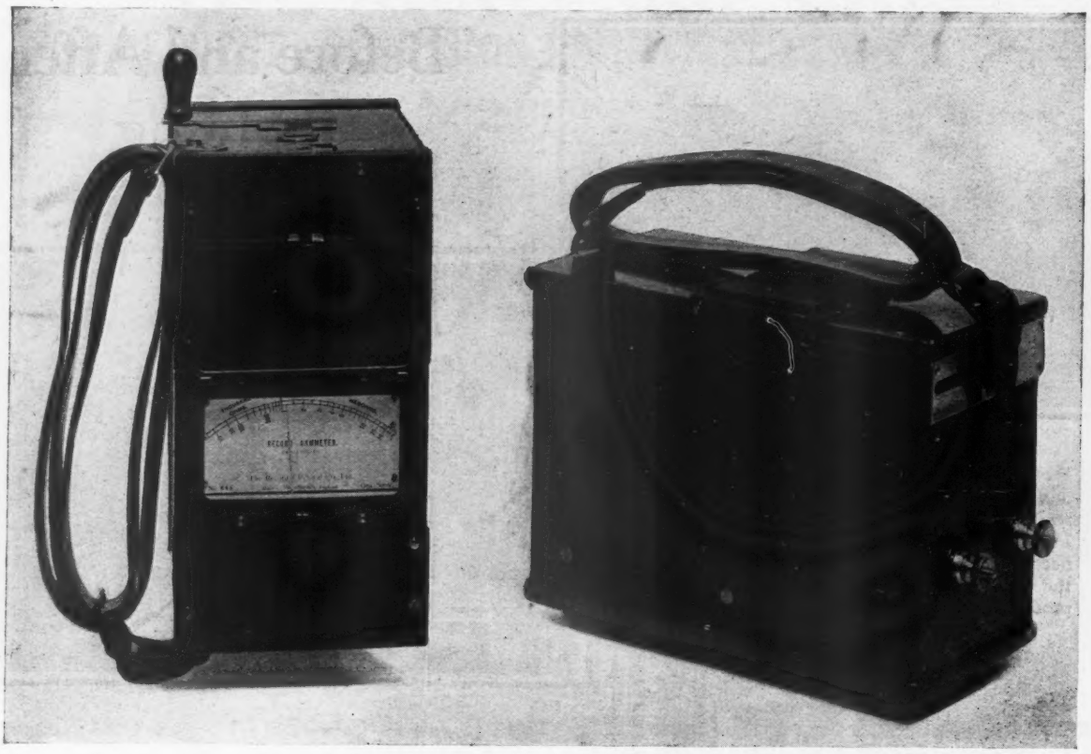
There must be no shadows, no reflections, and no glare—and all work and inspection must be illuminated so as to show the slightest flaw.

Good lighting pays a very handsome return on the money invested.

SANFORD L. CLUETT

THE MAKERS of the famous Victrola recognized the value of light after "considerable time devoted to the study of lighting." With the special booklet we have prepared on your particular kind of business, considerable time is not needed—we have done the studying for you. The booklet will be sent without obligation, if you write, mentioning your kind of business, to The Lighting Service Department, Edison Lamp Works of General Electric Co., Harrison, N. J.





CORY-RECORD OHMMETER

Electrical Engineers

Who believe in making insulation resistance tests will appreciate the value of the CORY RECORD OHMMETER.

The Ohmmeter is so light in weight and easy to operate that the most unskilled electrician can safely and accurately test your telegraph, telephone and power cables, interior wiring, feeders, switches, switchboard circuits, rotating electrical machinery, transformers, line insulators, etc.

It will increase your plant efficiency by helping to cut down expensive delays caused by faulty insulation conditions.

Write today for Catalog Bulletin 101-29-C and learn more about this valuable instrument

CHAS. CORY & SON INC.

Cory Building, 183-187 Varick Street, New York

BOSTON PHILADELPHIA SAN FRANCISCO

CHICAGO
Alberger Pump & Condenser Co.
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Reeves & Skinner Machinery Co.
2211 Olive Street

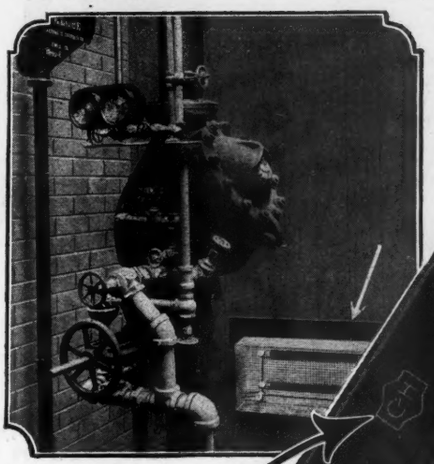
SEATTLE
W. S. De Pierris Co.
Hoge Building

Do You Want to Heat Your

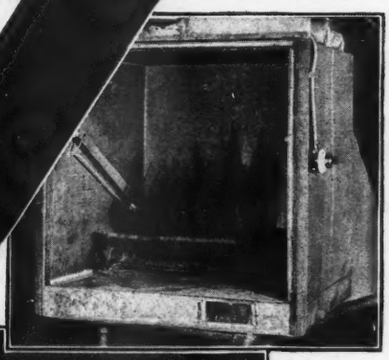
Sprinkler System Valve House?

Your Crane Cab?

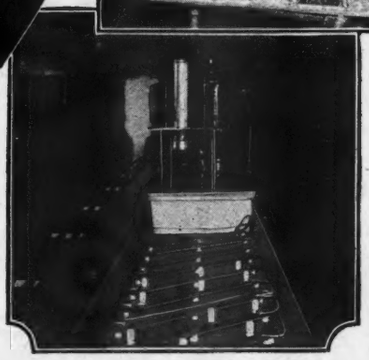
Your Japanning Ovens?



Two C-H Space Heaters in Sprinkler System Valve House.



Used in negative drying cabinet.



C-H Space Heaters replaced steam bath in cafeteria serving counter.

Do you want to apply heat for some manufacturing process; such as the warming of Bakelite or similar products before punching to prevent cracking of edges; do you want to prevent fuel oil from thickening; heat asphalt kettles; prevent condensation of moisture in pits and on underground electrical equipment? Several hundred thousand C-H Electric Space Heaters are in use for these purposes —over 2000 in one plant alone.

All these and 100 other applications are described in our booklet, "Dictionary of Uses"—all actual applications as told to us by users.

C-H Electric Space Heaters are so easily installed—they are flat—2 feet long—like a ruler with insulated mounting eyelets on either end. They may be connected to lighting or power circuits—take no more current than an ordinary household electric iron or toaster.

Space Heaters were developed by the same engineers who developed the numerous C-H products—men responsible for the application of electric heat to linotype pots, electric ranges, embossing press blocks, package sealing machines, soldering irons, glue pots, and many other industrial equipments.

Carried by electric supply houses everywhere — $3.00 each (East of the Rockies)—less in quantities. Order a carton of 10 today—a copy of "Dictionary of Uses" is enclosed.

THE CUTLER-HAMMER MFG. CO.

Industrial Heating Department

Works: MILWAUKEE *and* NEW YORK

Offices and Agents in Principal Cities

Northern Electric Co., Ltd., Can.

Send for this 64-page "Dictionary of Uses"

C-H CUTLER-HAMMER

SPACE HEATERS

"TWO FEET OF ELECTRICAL HEAT"

3 Inches in a Minute

Can you do this?

Do you know of an electric hammer-drill that will go through a three inch concrete slab in one minute? The SYNTRON will.

The lightest electric power hammer and drill on the market, it has only one moving part, makes 3600 strokes per minute and is impossible to get out of order. It can be attached to any electric light socket.

Furnished complete in cases for carrying, with an assortment of tools for all types and sizes of work.

This hammer is a necessity where any amount of chipping or drilling is done. We can prove it in dollars and cents. *Write for details.*

Fill out and mail the coupon, today, for prices and complete description of the Syntron Electric Hammer.

National Electric Mfg. Co.

650 Chatfield & Woods Building, Pittsburgh, Pa.

Sales Offices in Principal Cities

Three Types

Type F-Weight 9 Pounds
Capacity ⅝ inch
Type A-Weight 17 Pounds
Capacity 1 inch
Type B-Weight 26 Pounds
Capacity 1⅜ inch

For

Drilling through masonry walls
Drilling holes for expansion bolts
Chipping and cracking stone
Chipping metal and castings
Driving rivets
Light assembly work of all kinds
Squaring or breaking up stone and pavements
Calking pipes, tanks, plates, etc.
Vibrating
And any purpose where the rapid strokes of a hammer can be used

National Electric Mfg. Co.,
650 Chatfield & Woods Bldg.
Pittsburgh, Pa., U. S. A.

Gentlemen:
Please send me, without obligation on my part, catalog and prices on the Syntron Electric Hammer.

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SYNTRON
Electric Hammer

This Sample of the Ultimate Fuse Speaks for Itself

The sample will tell its own story of:

Time saved in renewing because of few and simple parts—only three and the renewal link.

No searching for parts lost or misplaced because there are no small loose parts.

Time saved in getting back into service quickly machines shut down because of the blowing of a fuse.

No more faulty renewals. You cannot put the BUSS Knife Blade Type Renewable Fuse together in the wrong way.

Long life because of sturdy construction and positive venting paths.

BUSSMANN MFG. CO.
St. Louis, Mo.

Fill in the coupon and mail it now

IE. 12-23

BUSSMANN MANUFACTURING CO.
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Without obligation, send me for examination sample 100 ampere, 250 volt Knife Blade Type BUSS Renewable Fuse.

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Company _____
Street _____
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BUSS FUSES

APPROVED IN ALL TYPES AND SIZES

TRADE BussFuses ELECTRICITY'S SAFETY VALVE MARK REG. U.S. PAT. OFF.

"ELECTRICITY'S SAFETY VALVE" MEANS ON

Where Dependability is Vital

Nordberg Accumulator for electric hoist control equipped with

Louis Allis
Heavy Duty
Type H.D. Motors

The Indestructible Rotor

of the "Louis Allis" type H. D. Motor eliminates uncertainties in the application of power, and assures the continuity of service, so vitally essential to the operation of hoisting machinery.

"L-A" Motors are the specified drive for the oil pumps of the Nordberg Accumulator. This device gives absolute and complete control over the brakes and clutches of the hoist. Its operation must therefore be positive and unfailing.

Mechanical infallibility is the prime objective sought in its design and construction and L-A Type H. D. Motors are relied upon accordingly.

THE LOUIS ALLIS CO.

formerly THE MECHANICAL APPLIANCE COMPANY

MILWAUKEE, WISCONSIN

L-A Motors

Watson Motors

World's Largest Single Enclosed Space

Heated with Skinner Bros. (Baetz Patent) Heaters

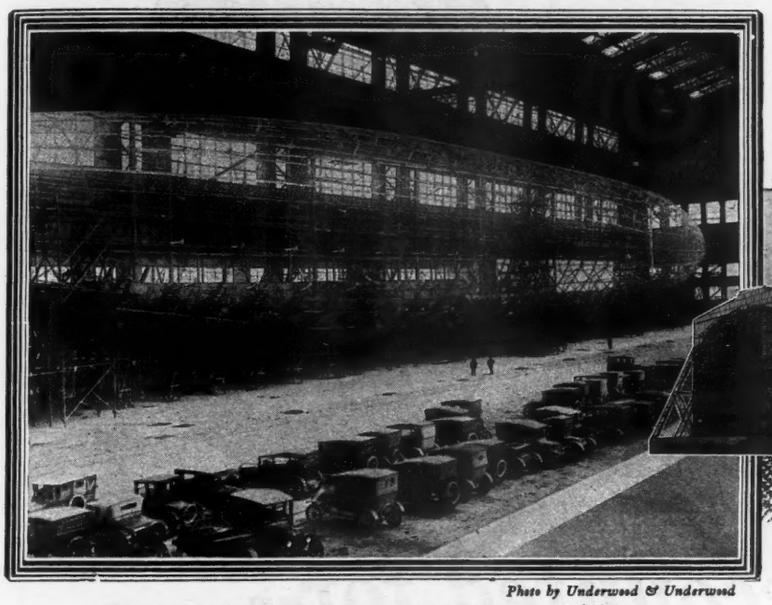


Photo by Underwood & Underwood

This shows the interior of the enormous Naval Hangar at Lakehurst, N. J.— heated with Skinner Bros. (Baetz Patent) Heaters.

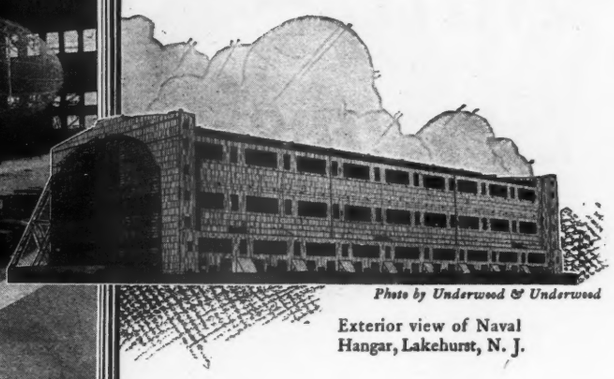
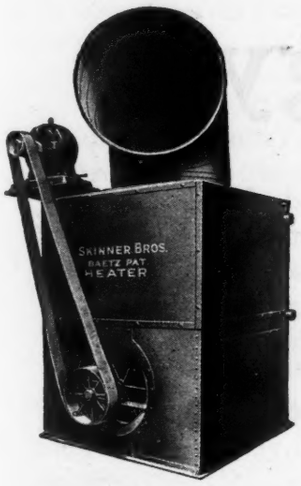


Photo by Underwood & Underwood

Exterior view of Naval Hangar, Lakehurst, N. J.



Steam coil type SC. Uses live or exhaust steam. Where steam is not available, we supply Direct Fired type DF. Burns coal, coke, wood, gas or oil.

The Naval Hangar illustrated above contains 57,000,000 cubic feet of air and is properly heated by only 16 Skinner Bros. (Baetz Patent) Heaters! The significance of this statement will be more apparent when it is pointed out that each of the Skinner Bros. (Baetz Patent) Heaters used is smaller than a Ford touring car.

This is only one instance where the superiority of Skinner Bros. (Baetz Patent) Heater has demonstrated itself—among many highly satisfied users are such firms as General Motors Corp., International Shoe Co., Ozark Theatre, Federal Foundry, Quick Meal Stove & Range Co., Ford Motor Co., United Paperboard Co., and hundreds of others, large and small.

Built on an Entirely Different Principle

The Skinner Bros. (Baetz Patent) Heater is built on a principle totally different from old style apparatus. It uses no pipes or ducts as warm air carriers yet it thoroughly warms every part of the open area in a building. Due to special design, it can also be used as a ventilator and air conditioner—operates economically both summer and winter.

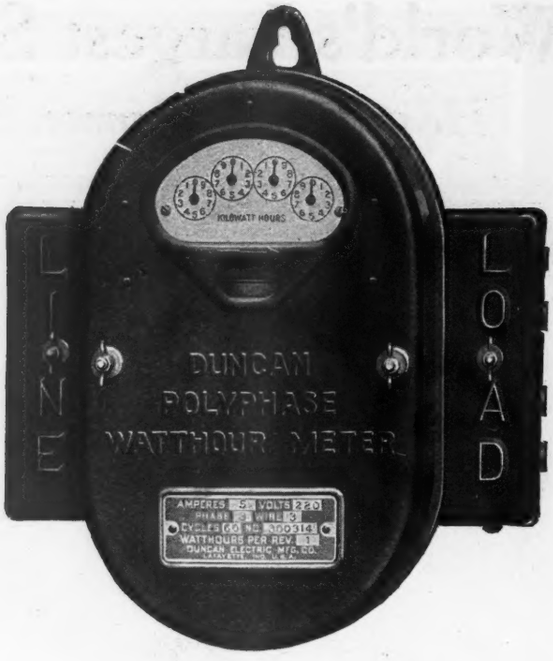
Get full details—ask for catalog E-9 and full list of users.

SKINNER BROS. MFG. CO., INC. Main Office and Factory: 1474 S. Vandeventer Av., St. Louis, Mo.
Eastern Office and Factory: 140 Bayway, Elizabeth, N. J.

Boston, 445 Little Bldg. Buffalo, 702 Morgan Bldg. Chicago, 1703 Fisher Bldg. Cleveland, 612 Marshall Bldg.
Cincinnati, 1050 Hulbert Bldg. Oliver Schlemmer Co. Wash., D. C., 714 Evans Bldg., U. D. Seltzer Phila., Pa., 1711 Sansom St. Haynes Selling Co.
New York, 1702 Flatiron Bldg. Pittsburg, 8 Wood St., Pittsburg Heating Co. Spokane, 409 First Ave., H. B. DeLong Co. Detroit, 308 Scherer Bldg.

Skinner Bros.

Baetz Patent HEATING SYSTEM



Oil--
Nails--
Screws--
Washers--

--all are accounted for--

Why not Energy?

Competition and modern business methods demand of the manufacturer an accurate knowledge of what his products cost him. An essential part of the cost of any manufactured product is the expense of the power used in producing it. It takes a certain amount of energy to perform a given operation and POWER COSTS MONEY—it enters into the cost of production just as much as material and labor.

A watthour meter installed on each department or major operation will greatly increase the accuracy of the cost system and the Duncan watthour meter because of its high initial and sustained accuracy in service, its long life and ease of adjustment and freedom from repairs is admirably suited to the requirements of such service. Write for bulletins.

Duncan Electric Manufacturing Co.

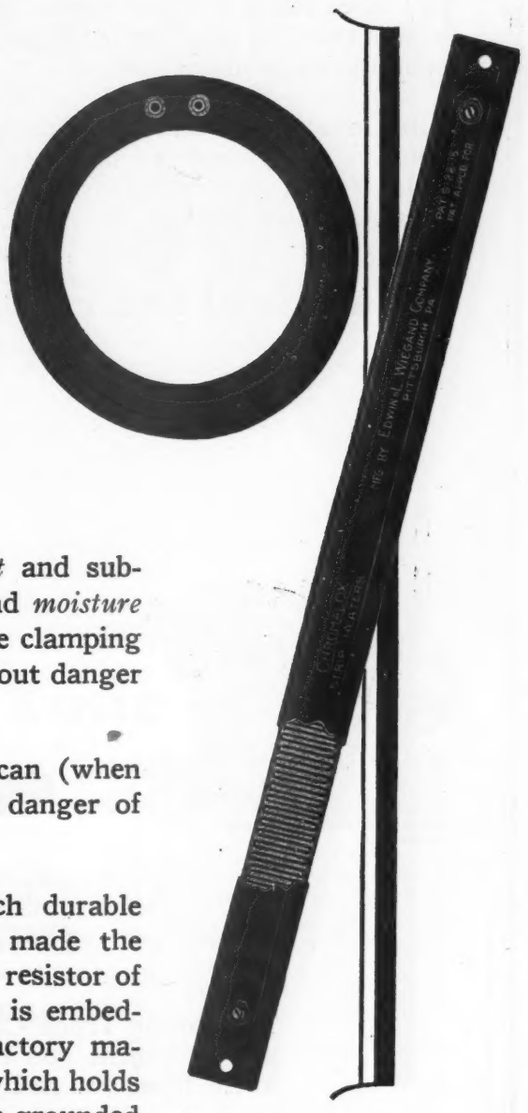
Lafayette, Indiana

Can you overload the heater you are now using 500% without damage?

On repeated tests by interested parties the 2 foot 500 watt "Chromalox" Strip Heater has withstood over 600% rated input without damage. Voltage variation therefore has no damaging effect on these heaters.

They can be supplied in standard overall lengths of 12", 18" and 24" for voltages ranging from 55 to 250 and wattages to meet your specifications. A "strip of heat" for every purpose.

Lengths up to 6 feet can be supplied on special order.



"Chromalox" Strip Heaters are *light in weight* and substantially constructed — being *completely enclosed* and *moisture proof*. The terminals are on one side, permitting the clamping of the heater to smooth surfaces when desirable without danger of grounding.

They are ground tested on 1100 volts. They can (when conditions permit) be operated at 1400° F without danger of destroying the heating element or terminals.

The reason for such durable units is that they are made the "Chromalox" way. The resistor of nickel chromium ribbon is embedded edgewise in a refractory material under hydraulic pressure of one hundred tons which holds the resistor rigidly in place preventing open, short or grounded circuits.

Place a trial order today. If your electric supply house does not have them in stock, write direct and we will see that you are supplied.

Booklet (F-10-I) and price list will be sent at your request. Fill out the coupon and mail today.

CHROMALOX

Trade Mark Reg. U. S. Pat Off.

"The Mark That Identifies"

Edwin L. Wiegand Co.

422 First Avenue

Pittsburgh, Pa.

Edwin L. Wiegand Company, 422 First Avenue, Pittsburgh, Pa.
Please send me booklet (F-10-I) on "Chromalox" Strip Heaters.

Name..... Company.....

Address..... City.....

Stop up the profit-draining hole of manual load handling

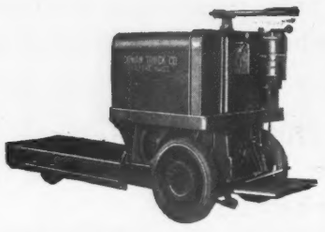
FOR example, it made it possible for one concern to effect a 43 per cent reduction in handling costs.

Many executives have, unexpectedly, found a surprising number of these "holes," through a casual stroll through the shop or warehouse.

Here, two or three men loading a factory truck—when one, with the proper equipment, could do the work. There, five, six or more rehandlings of materials on their way through progressive manufacturing operations and storage —though all could be easily eliminated.

Cowan Hand and Electric Lift Trucks and Cowan Skids Cut Handling Costs

Cowan Hand Lift Truck. Powerful and easy lift. Positive lock. Moves with little effort. Cowan special unloading device. Automatically adjusting check. Alemite lubrication.



Cowan Electric Elevating Truck. Powerful Motors. Positive braking and control. Anti-kick steer. Capacity. Absolute dependability. Speed of operation. Alemite System properly applied.

Cowan Long Life Skid. Strength, Rigidity, Long Life. Price consistent with quality Remember price must include future maintenance costs.

The Cowan Truck Company offers you the most economical equipment you can purchase, not always in price but in the thing you really pay for—results.

We have a Bulletin devoted to your particular business. Send for it.

We call your attention to our Custom Department for your trailer and special problems.

COWAN TRUCK CO., 12 WATER ST., HOLYOKE, MASS.

Representatives in Principal Cities

Largest Manufacturers of Complete Hand and Electric Industrial Truck Systems

2076-N

Chain the Motor to Your Machine

TRANSMIT your power without slip. Place the motor to suit your convenience, on short centers, and enclose the silent chain drive in a Link-Belt dust-proof, oil-retaining "Safety-First" casing.

Then you will have an effective drive, one that will give long, dependable service.

Link-Belt Silent Chain is flexible as a belt—positive as a gear—more efficient than either—(98.2% efficient on actual test).

LINK-BELT COMPANY
910 S. MICHIGAN AVENUE CHICAGO
(OR NEAREST OFFICE LISTED BELOW)

Please send postpaid—Link-Belt Silent Chain Data Book No. 125.

Name _____
Firm _____
Street _____
Town _____
State _____
Industrial Engineer.

RETURN THIS COUPON

LINK-BELT COMPANY

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Boston 49 Federal St.
Pittsburgh 335 Fifth Ave.
St. Louis 705 Olive St.
Buffalo 745 Ellicott Square
Wilkes-Barre 826 Second Nat'l Bank Bldg.
Huntington, W. Va., Robson-Prichard Bldg.
Cleveland 329 Rockefeller Bldg.
Detroit 4222 Woodward Ave.
Kansas City, Mo. 307 Elmhurst Bldg.
Denver, 520 Boston Bldg.
Atlanta, 24 Marietta St.
Louisville, Ky. 321 Starks Bldg.
New Orleans 504 Carondelet Bldg.
Birmingham, Ala. 720 Brown-Marx Bldg.
Charlotte, N. C., J. S. Cothran, 909 Com'l Bank Bldg.
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1398

LINK-BELT
SILENT CHAIN DRIVES

New DREADNAUGHT *Portable Cord*

rubber covered

This new **PARANITE** cord, like all other wires and cables bearing this label, is "more than code requires" in all the details of its manufacture.

More than this, Dreadnaught Portable cord is superior to the usual rubber covered portable cords now sold.

The rubber cover, thick, tough, practically everlasting even in the severest service, is of the same quality as the rubber in high grade tire treads.

This thick rubber cover is put on under enormous pressure over the double conductors, which are insulated with 30% rubber and braided with an indicating tracer. Pressure forces the soft, unvulcanized rubber tightly around the conductors. The pressure is maintained and after vulcanizing the result is a tough, dense wall of live rubber that withstands wear remarkably.

It's **PARANITE** quality and service all the way through.

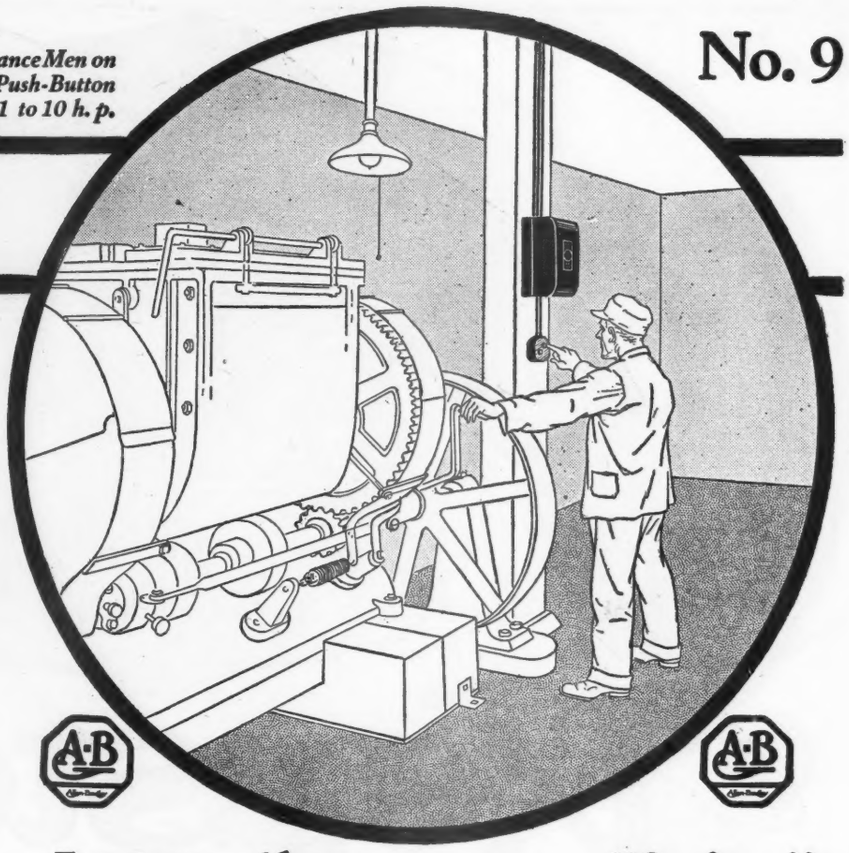
Indiana Rubber & Insulated Wire Co.
Jonesboro, Indiana
810 Marquette Bldg., Chicago
The Thomas & Betts Co.
63 Vesey St., New York

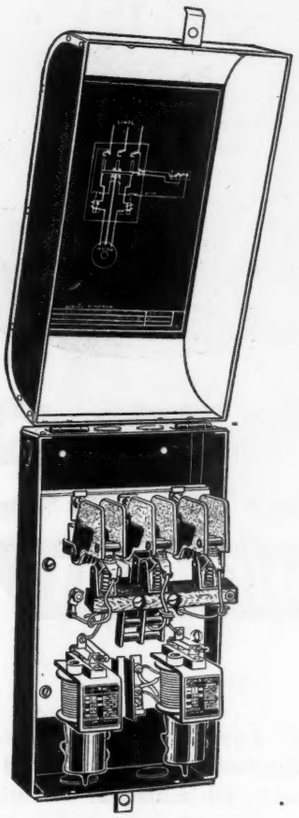
If it's **PARANITE** *it's right*

One of a series of talks to Maintenance Men on the Allen-Bradly Type J-1552 Push-Button Starter for Induction Motors of 1 to 10 h. p.

No. 9

Safety





Some Big Features

1—Arc shields and blow outs on ALL phases.

2—Inverse time element overload relays.

3—Copper-to-copper rolling contacts.

4—Roomy steel enclosing cabinet.

5—Knockouts for conduit wiring.

J-1552 Always means "Safety"

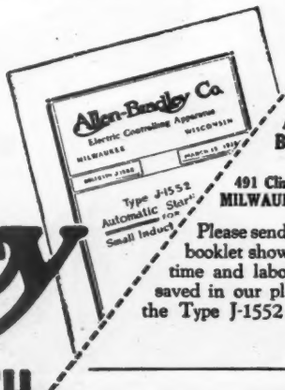
1st—To Men, because the touch of a button starts or stops the motor with no more risk to the workman than the pushing of an electric light button. The switch is enclosed and all "live" parts are not accessible to the shop hand. The motor cannot start accidentally after a shut-down.

2nd—To Motors, because the accurate time limit overload relays detect continued overloads and stop the motor before a burnout is possible.

3rd—To Machines, because the motor cannot continue to operate with a heavy overload, as is often the case with over-fused starting switches. The relays automatically reset to the correct value after tripping.

Play safe—always order the J-1552

Allen-Bradley Co.
Electric Controlling Apparatus
491 Clinton Street, Milwaukee, Wis.



ALLEN-BRADLEY CO.
491 Clinton Street
MILWAUKEE, WIS.

Please send me your booklet showing how time and labor can be saved in our plant with the Type J-1552 Switch.

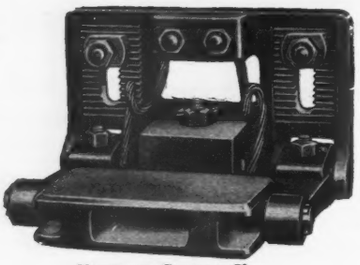
_____

_____

Allen-Bradley

TYPE J-1552

ACROSS-THE-LINE STARTING SWITCH



Keystone Contact Shoe

A Typical Universal Keystone Collector

Keystone Standard Type Contact Rail Shoe Assembly for Over-Running Contact

Keystone Third Rail Equipment will permit the maintenance of reliable electrical contact at all times, indoors or out. It meets all industrial conditions as proved by an extensive list of diversified industries, representative of which are:

American Car & Foundry Co.; Baldwin Locomotive Works; Carnegie Steel Co.; General Motors Corp.; Hartford Electric Light Co.; Link Belt Co.; Philadelphia Rapid Transit Co.; Victor Talking Machine Co.; Youngstown Sheet & Tube Co. and many others.

For your third rail electrical system and carrier contact, specify reliable sturdy, proven Keystone Equipment.

Send for data sheets

ELECTRIC SERVICE SUPPLIES CO.

Electric Railway and Mine Haulage Material

PHILADELPHIA 17th and Cambria Sts.
PITTSBURGH 829 Oliver Building
SCRANTON 316 N. Washington Ave.
NEW YORK 50 Church St.
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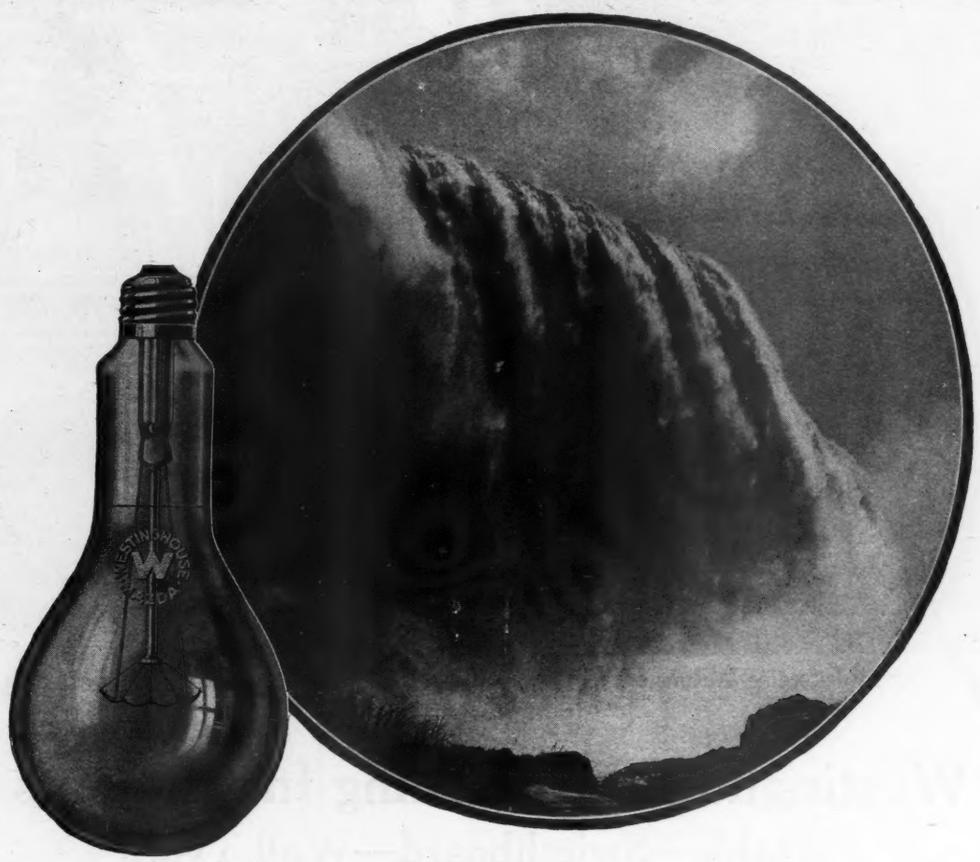
Canadian Agents
Lyman Tube & Supply Co., Montreal, Toronto, Winnipeg



The Test of Quality Is Demand

The capacity of one of the largest hydro-electric power plants at Niagara Falls is over 227,000 kilowatts.

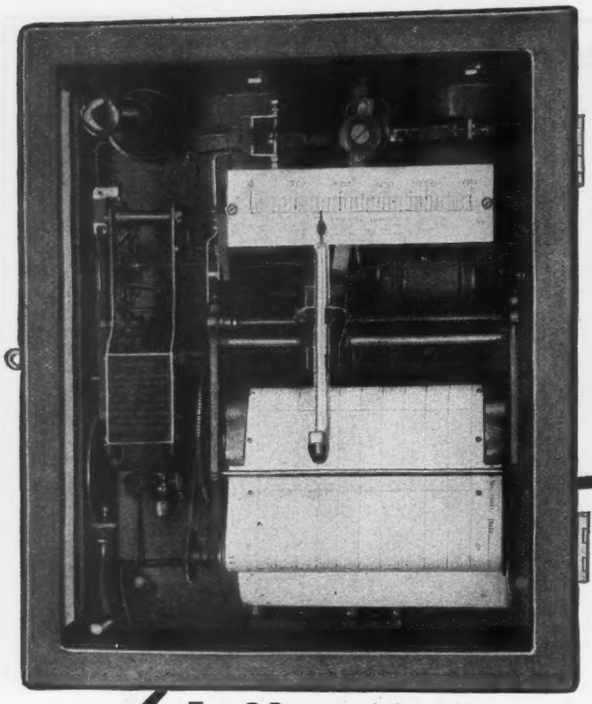
As huge an amount of power as this represents, it would not be sufficient to light the total number of Westinghouse Mazda C (gas-filled) Lamps manufactured in a period of thirty days.

The demand for Westinghouse Mazda C Lamps has increased so tremendously that it has necessitated a constant expansion of manufacturing facilities.

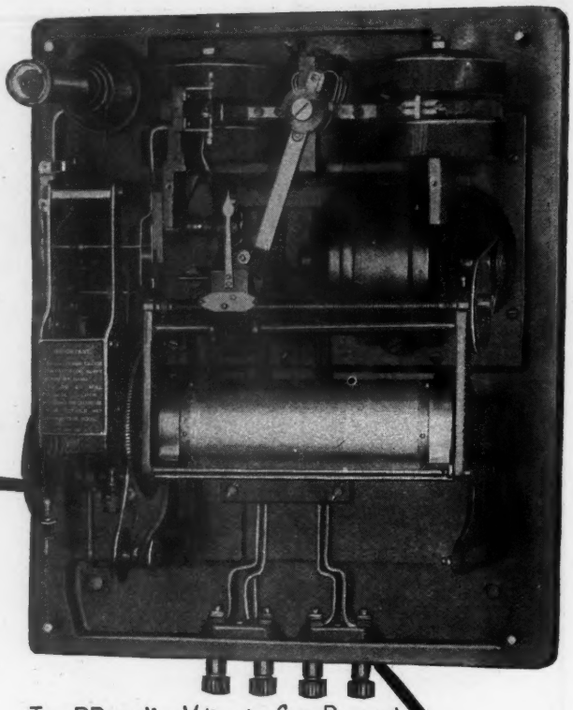
This is due directly to the proven fact that the Mazda C Lamp, when used with the proper reflector, is the most efficient and economical lamp for the general lighting of factories, offices, and stores.

WESTINGHOUSE LAMP COMPANY
165 BROADWAY, NEW YORK, N. Y.
Sales Offices and Warehouses Throughout the Country
For Canada: CANADIAN WESTINGHOUSE CO., Ltd., Hamilton, Canada

Westinghouse



Type R Recording Wattmeter



Type R Recording Voltmeter, Cover Removed

Westinghouse Recording Instruments

Portable—Switchboard—Wall Types

—have the following advantages:

Improved zero reset. Stronger calibrating spring. Improved pen carriage. Larger control motor. Improved re-roll mechanism. Large, accessible terminal studs.

All these instruments have indicating dials rendering the use of separate indicating instruments unnecessary, thereby making a distinct saving in certain installations.

Particularly adapted for recording and indicating the total power generated by central stations. Very useful for recording maximum demand; line voltage; station curves; arc circuits; electrolysis; motor tests; and electric traction investigations.

They are also very useful instruments for various engineering investigations and for recording the performance of cranes and hoists; printing presses; steel rolling mills; textile mills; paper mills; and other industrial plants.

Write for Leaflet 20049 which gives full particulars

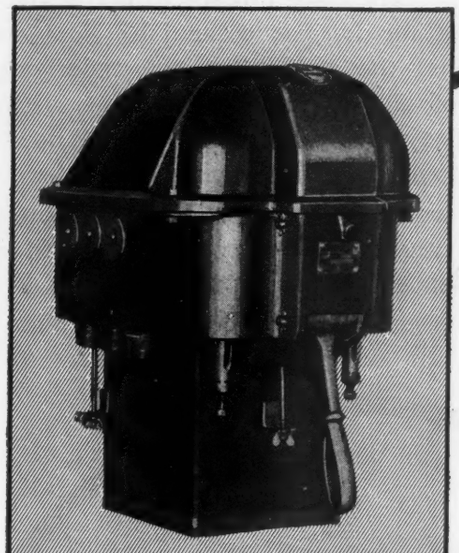
Westinghouse Electric & Manufacturing Company
Newark Works, Newark, N. J.

Sales Offices in All Principal Cities of the United States and Foreign Countries

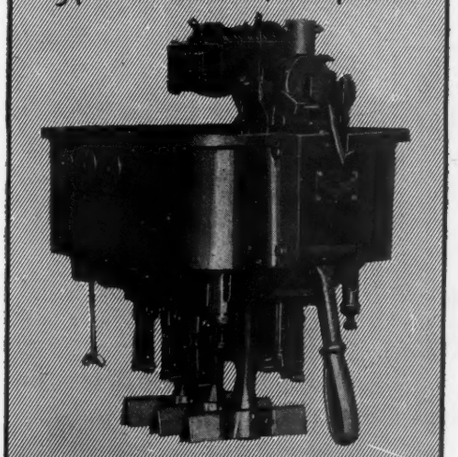
Westinghouse

A Westinghouse Oil Circuit Breaker, Type F-10, For Industrial Applications

Capacities up to 200 amperes, 2500 volts; 300 amperes, 750 volts. Indoor service, Automatic and Non-Automatic Direct Control, Wall, or any vertical-surface mounting.



Type F-10 Breaker, Complete



Type F-10 Breaker, Cover and Tank Removed.

The Type F-10 Oil Circuit Breaker is simple, reliable, inexpensive and sturdy in construction. It satisfactorily controls motor circuits and other low power-factor loads.

The illustration shows a Type F-10, 200 ampere, 2500-volt, 3 pole, single-throw breaker, equipped with full automatic, series-current trip overload coils inverse time limit, and under-voltage-release attachments, and voltage transformer.

Furnished also with electric lockout, and interlock device.

The Type F-10 Oil Breaker is fully described in Descriptive Leaflet 3400; ask for a copy.

Westinghouse Electric & Manufacturing Co.

East Pittsburgh, Pa.

Sales Offices in All Principal Cities of the United States and Foreign Countries

W WESTINGHOUSE ELECTRIC

A Drip-proof and Dust-proof Breaker for Industrial Application.

Westinghouse

The Name and

When the name Westinghouse made its first appearance upon a piece of electrical apparatus it was conceived and placed there as a mark of the inherent integrity of the equipment. Our Founder set the highest ideals as his standard, laid his plans accordingly, and so built his organization that the slightest deviation from the original purpose would not be tolerated.

So, today, the circle "W" trade-mark upon a motor is the absolute guarantee that it is of the highest quality. Many years of engineering design and manufacturing experience are built into every Westinghouse motor. These motors have stood the test of time, the abuse of man and machinery, and have successfully met the most gruelling demands ever placed upon motor service.

Each industry naturally makes different demands upon a motor. To meet just such conditions, Westinghouse engineers made a thorough study of the requirements of each operating condition, and from this practice sprung the complete line of Westinghouse motors. Some are designed and made especially for particular work, such as textile and paper-machine motors. Others are made dust-proof and water-proof, each for its particular job. But no matter what the application, the underlying principle of all Westinghouse motors is the same. They are like the proverbial house that was founded upon a rock.

Is it any wonder that Westinghouse motors are doing duty in every corner of the earth to the complete satisfaction of their operators?

Should they not be doing duty in your plant?

The Westinghouse type CS motor—ready for active campaigning.

Westinghouse
Electric & Manufacturing
Company
East Pittsburgh, Pennsylvania
Sales Offices in
All Principal Cities of the
United States and
Foreign Countries

W
WESTINGHOUSE
ELECTRIC

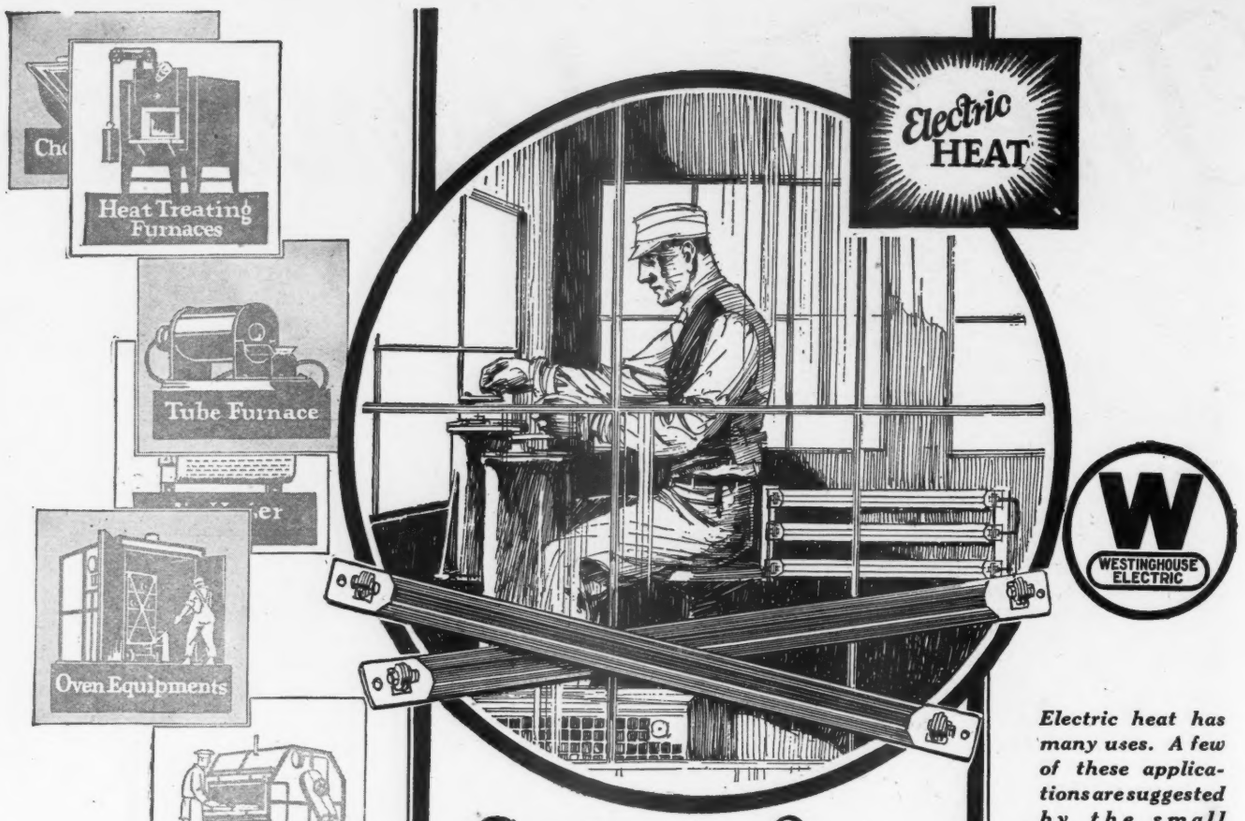
Westinghouse

The Trade-mark

A series of advertisements recently run, outlining Westinghouse developments in the electrification of diversified industries.

A part of a window display celebrating the fifty-second anniversary of a large Pittsburgh merchant. The motor has been retired from active duty, but there are many others built upon its experience.

Westinghouse



Strips of *Electric* Heat

Electric heat has many uses. A few of these applications are suggested by the small sketches. Electric heat can be used in your business.

Right now is the time to install them; when Jack Frost is beginning to reach out with his cold fingers to nip some of those exposed pipes—when the watchman begins to visit the boiler room frequently because his shanty is so cold—when you begin to realize it is almost cruelty to ask a man to work all day in a cold crane cab.

Westinghouse electric space heaters save all this inconvenience. They are inexpensive, easy to install, and do not cost much to operate. Let your electrician wire up a couple of space heaters in some of those hard-to-heat places, and see how nicely they take the chill off on a cold morning. No fumes, no dirt, no flames to start a fire. Just turn on the heat when you need it, and turn it off when you are through.

A postal to the nearest Westinghouse office will bring sizes and prices. Better hurry, before cold weather sets in.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

East Pittsburgh Pennsylvania

Sales Offices in All Principal Cities of the United States and Foreign Countries.

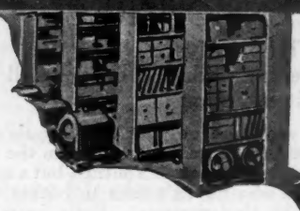
See Your Telephone Directory

Send for your copy today.

An occasional publication containing accounts of heating installations of interest to every executive. We shall be glad to put you on the mailing list. Write for a copy today.

Westinghouse

MAINTENANCE SERVICE, REPAIR PARTS, TOOLS AND SUPPLIES



In the maintenance departments of every industrial works and in every commercial electrical repair shop the range of the work that can be done and the dollar-savings that are possible depend on:
(1) The ability and experience of the maintenance man.
(2) Adequate hand and bench tools and shop equipment.
(3) A well-balanced stock of spare units, parts, wiring supplies and raw material used in repair work.
Here then is a directory to the needs of the maintenance man under items (2) and (3) that he can use when he must have things in a hurry on an emergency job and when ordering for stock to meet his regular maintenance requirements.

OUR RECOMMENDATION IS YOUR PROTECTION

CARROLL
ELECTRIC COMPANY, Inc.
COMPLETE STOCK
WIRING SUPPLIES
MAZDA LAMPS
MOTORS
MACHINERY
EQUIPMENT
Prompt Shipment from Either
BALTIMORE, MD. 38 S. Calvert St.
WASHINGTON, D. C. 714 12th St., N. W.

Send for descriptive folder on "Little Giant" and "Big Buster"

PRACTICAL PULLING TOOLS
—that fill an every-day need

The "Little Giant" and the "Big Buster" cover a range of work which is not approached by any other combination of pulling tools on the market. These tools cannot spread, turn or slip off the work; no arm locks required.

"THE HARDER THE PULL—THE TIGHTER THE GRIP"

A principle quickly understood and appreciated by mechanics who have had experience with ordinary pullers.
"Little Giant" and "Big Buster" will easily and quickly pull commutators, wheels, pulleys, gears, pinions, bearings or anything with a tight fit or that is hard to get at with ordinary tools.
The "Little Giant" is the only Puller permitting adjustments of one or more arms to different lengths for uneven inside or outside pulls. This Tool has FOUR arms.

PREMIER ELECTRIC COMPANY
MANUFACTURERS—EST. 1905
3804 RAVENSWOOD AVENUE CHICAGO

Send To-day for the "Electrical Worker's Friend"

An electrical book of 66 motor drawings with complete instructions for rewinding and reconnecting A. C. motors. Special at..... $3.00

Or write for full particulars of this valuable book

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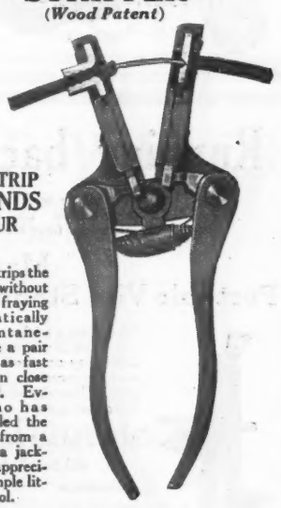
precision

PRECISION, simplicity of construction, durability.
And quick delivery.
These are the factors responsible for the wide adoption of FLOWER Brush Holders.
Our illustrated bulletin showing many models will be mailed you upon request.

FLOWER brush holders
D. B. FLOWER, 1217 Spring Garden Street, Philadelphia
Manufacturer of Brush Holders for Motors, Rotary Converters, Generators and Dynamos.

BARD-PARKER
WIRE INSULATION STRIPPER
(Wood Patent)



WILL STRIP 1200 ENDS AN HOUR

Cuts and strips the insulation without nicking or fraying—automatically and instantaneously—like a pair of pliers, as fast as you can close your hand. Everyone who has ever whittled the insulation from a wire with a jackknife will appreciate this simple little hand tool.

$5.00 f.o.b. New York
Ask your dealer or write us direct.
Bard-Parker Company, Inc.
150 Lafayette St. New York, N. Y.

TINOL
Solder in Paste Form
contains no form of acid or harmful salts. Best and safest solder to use for all delicate soldering operations. Endorsed by the largest electrical manufacturers in the country.
Write for sample and prices.
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NO Spark Carbon Brushes
are Self Lubricating. They last longer and serve better than ordinary brushes. Give them just one trial.
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Radial Grinder & Drill
— for Abrasive, Buff, Scratch Brush. All sizes.
Write for Bulletin G-1
Stow Mfg. Co., Inc.
Binghamton, N. Y. U. S. A.

Just What I Want!

"AUTEX" EXTENSION REEL
FOR ELECTRIC LAMPS
Also extensively used for electric drills and other small electrical unit extensions.

Take your lamp with you to any part of your machine-shop or garage—an automatic lock holds it at any desired distance from the reel. In no sense a "half-baked" proposition nor an amateur's outfit—but a splendidly strong Extension Reel for people who haven't time to bother with nonsensical makeshifts. Approved by Underwriters. Fully protected by patents. Full particulars furnished on request.

THE CINCINNATI SPECIALTY MFG. CO., Inc.
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SAFETY CARTRIDGE
FUSE REMOVER
$2.50

BUSH
SAFETY TOOLS
ARE THE CHEAPEST KIND OF INSURANCE

No Shocks or burns
Made of special insulating compound
Operates with one hand
Mechanically and Di-Electrically strong

Write for Bulletins

BUSH ELECTRIC CO.
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Running back and forth

from job to work bench isn't productive time. That's why the most progressive firms are buying

10 DAYS FREE TRIAL

Martin
Portable Vise Stands and Pipe Benders

Give them a trial—they won't cost you a cent if you aren't entirely satisfied they are the best buy you've made in months. 10 days *free* trial offer. Descriptive literature and prices on request.

H. P. MARTIN & SONS
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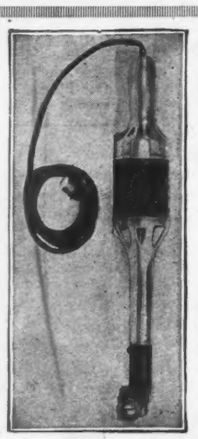
Owensboro Kentucky



Increase Production—Cut Power Costs

Keep your Electrical Machinery at top efficiency. Use

Aurand Slotter
Acme Stones
Acme Cement
Emery Blower

Save Time, Money and Material in turning, repairing, undercutting and cleaning Commutators, and Collector Rings. Write us and we will tell you how to try it out at our expense.

Green Equipment Corp.
330 S. Dearborn St. Chicago, Ill.

PAINE Expansion Shells give satisfaction and cost less than any of the steel or malleable types. Eleven years of satisfactory service. Bolts furnished with shells making complete unit ready for use on the job.

Send for Sample

THE PAINE COMPANY
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Motor Manufacturer's and Electrical Repairer's Equipment
A-C-E

Coil Winding and Forming Machines are used the World Over, and are indorsed as the best on the market.

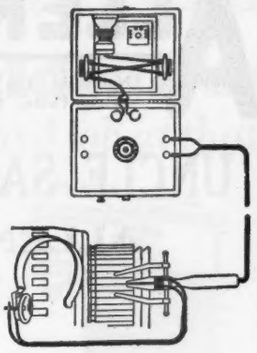
? WHY ?

BECAUSE they have proved their worth in Saving Time and Labor, and giving Complete Satisfaction.

Write for Catalog and Prices

ARMATURE COIL EQUIPMENT CO.
2415 Forestdale Ave., Cleveland, Ohio
Manufacturers of Complete Motor Repair Equipment.

The Century Armature Tester is a quick and certain detector of faults in armatures. It instantly detects and exactly locates shorts, opens, wrong connections, and grounds, without unsoldering any of the lead wires from the commutator or disturbing the hoods. It is adapted for use with either alternating or direct current, or with a battery when power circuits are not available. It is supplied with both Receiver and Meter types of testing forks and ground detector. Write for descriptive folder and prices.



Century Electrical Co.

Manufacturers of Armature and Field Coil Testing Apparatus.

Syracuse, N. Y.

$26.00 SET FOR $12.00

(SUBJECT TO PRIOR SALE)

MAGNETO TEST BELLS

Leather Case Aluminum Frame

For testing line circuits for shorts, leaks and opens, testing armature coils, field coils and transformer coils or any tests made with generator and buzzer. Made to Government specifications.

Only chance to buy at this price is while this stock lasts.

American Electric
COMPANY
6500 S. State St.
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ALUMINUM

For D. C. Motors and Magnets

Advantages of Aluminum Field Coils—

Permanent insulation.
No baking or charring of insulation.
Uniform distribution of heat.
Quick conduction of heat.
Moisture and heat resisting.
50% to 60% weight reduction.
Brass spools not needed on large coils.
Less chafing due to lighter weight.
Less terminal trouble.
Longer life—less renewals.

Lind Aluminum field Coils have been in use in Europe for the past fifteen years. Since they have been manufactured in America they have been successfully used by more than 60 different companies, and many repeat orders have been placed.

They have the same number of turns as the coils which they replace and since the aluminum oxide insulation is an integral part of the coil, internal shorts are practically eliminated. And they are doubly protected against external failures.

If you haven't tried these coils send in an order for a set—there's even a price advantage for many types.

Illustrated Bulletin Sent on Request

Economy Electric Devices Company
L. E. GOULD, Pres.
1590 Old Colony Bldg., Chicago

FIELD COILS

At Last a Real BELT CUTTER

When you know the features of the New Detroit Belt Cutter you will agree that no belt user can afford to be without it.

The knife arm lifts to make it easy to apply the belt. It squares a belt with perfect accuracy—fully guaranteed.

Made by the makers of "DETROIT" Belt Lacing and Closing Machines

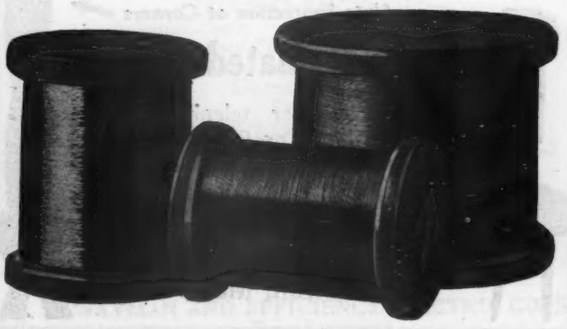
Nothing has been spared to make it the most efficient device for its purpose.
Made in two sizes—6" and 10". Write for folder.
Order now if you want delivery within 30 days.

DETROIT BELT LACER CO.
Detroit, Michigan, U. S. A.
Branch Offices in Large Cities Licensees in Foreign Countries

MAGNET WIRES

Specializing in Service
to
Repair Shops
and
Maintenance Departments

MARING WIRE COMPANY
Factory and Executive Office
MUSKEGON, MICHIGAN



Turn the handle—and read insulation resistance directly in ohms (or megohms)

Made by the makers of Megger Testing Sets

The "MEG" Insulation Tester

"Just the thing" for trouble-shooting, acceptance tests and tests after repairs on generators, motors, short-length cables, switchboards, wiring installations and transformers where 100 megohms is "high enough."

Helpful information on the subject of insulation testing is contained in our Pocket Manual 1010-E. Descriptions of the "Meg" and the new "Super-Meg" are included.

Write today for this Manual

James G. Biddle

1211-13 Arch Street, Philadelphia

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Non-Acid—For Soldering. Five Forms Stick, Paste, Salts, Liquid and Oil

UNCLE SAM SPECIFIES "ALLEN OR EQUAL"

After you have tried a sample of Allen Non-Acid Sodering Flux, we know you will specify

"ALLEN OR NOTHING"

SEND FOR A FREE SAMPLE.

Approved by the National Board of Underwriters.

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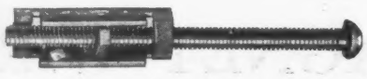
4531 North Lincoln St. CHICAGO, ILL.



CHICAGO Toggle Bolts

Save both time and labor by using Chicago Toggle Bolts. They hold under all conditions. They never break or pull out under severest strains. No other toggle is so easy to apply. Write for sample.

Chicago Expansion Bolt Co.

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600 Catalogues

in 1 Volume

For Buying Facts Regarding

INDUSTRIAL and POWER PLANT MATERIALS and EQUIPMENT

—See—

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Note Protection at Corners

Blake Insulated Staples

Unequalled for telephone and bell wiring. The fibre insulation prevents troublesome short circuits and grounds. 4 sizes. Pat. Nov., 1900. Write for Samples.

Blake Signal & Mfg. Co.

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A Gerstner Tool Chest

Will keep your tools safely and in order

A splendid piece of equipment for the man with valuable tools. The type shown here is made in two sizes in Mission finish. Both roomy, practical, strong. The lid is removable, is fitted with a good lock, and slides under bottom drawer.

Write us for prices and for catalog showing other styles.

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16,200 Welds a Day
—and an awkward job at that!

But it doesn't matter—the more cumbersome the article is to handle and the more difficult the work, the more emphatically Taylor Spot Welders prove their superiority. One Detroit manufacturer makes the above record regularly on one machine!

You may find Taylors just the cost-reducing factor you seek!

Universal Type S-6-2

The TAYLOR WELDER CO.
WARREN, O.

QS - 1

Write for full particulars about—

TAYLOR SPOT WELDERS

TIREX NEVER KINKS

TIREX RUBBER ARMORED CORD
FOR ELECTRIC TOOLS

Two or three conductor Nos. 18, 16 and 14 and two conductor No. 12 are packed in special cartons containing 250 feet each, so constructed that the cord may be drawn out as needed without disturbing the remainder of the coil. All sizes are furnished in special lengths as ordered.

SIMPLEX WIRE & CABLE Co
MANUFACTURERS
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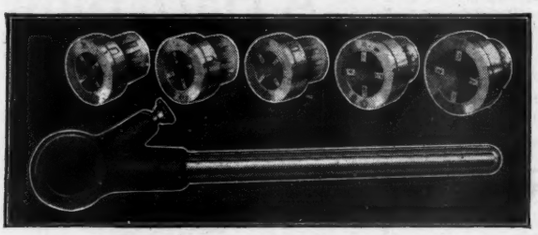
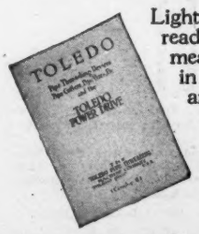
CHICAGO SAN FRANCISCO NEW YORK



This Little Ratchet Threader Meets the Need

For the close-corner job, for the bench job or for any ⅛" to ¾" threading job this little "Toledo" No. 00 tool is ideal.

"TOLEDO" TRADE-MARK REGISTERED



Light, weighing ready for work but 3½ lbs.; compact, measuring but 14" long, it may be carried in the pocket if desired. Threads easily and produces smooth, perfect threads.

The "Toledo" No. 00 is just one of the complete "Toledo" line of cutting and threading equipment, shown in this new catalog. Drop us a post card to-day for your copy.

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TOLEDO, OHIO
New York Office, 50 Church Street 54

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THREADING DEVICES POWER DRIVE · PIPE CUTTERS

Refillable Plug Fuses

WILL SAVE OVER
80%
Of Your Annual Fuse Expense.

Simple to Assemble

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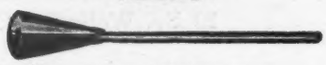
No Parts to Loose or Get Out of Order



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USE NO TOOLS FOR THIS FUSE
List prices subject to liberal discounts, which will be quoted on application.

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Bell Phone 264
Successor to
WAYMAN AND EFFICIENCY ELECTRIC CO.'S
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"The Clip With the Grip"

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Saves Fuses
Specify Reinforced Clips When You Order Switches.
Avoid Delays

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Consigned Stock
Rome Electrical Company

STANDARD
INSULATING VARNISHES

ARTHUR B. WEEKS
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Jobbers of
ELECTRICAL SUPPLIES

Motors and Generators
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High-Grade Electrical Repair Work

THE W.G. NAGEL ELECTRIC CO.
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Soldering IRONS

Here is an all-round electric soldering iron for a thousand and one industrial uses. It operates from an ordinary lighting circuit. Includes 6 ft. cord and 2-piece plug. Also made with 3/8" point for fine work.

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The Prompt Use of
EARLY'S COMMUTATOR CEMENT
in the pitting of commutators, will prevent a break down of the motor or generator. The machine can be set running again in a few minutes.

The Edw. E. Early Co.
Canton, Ohio

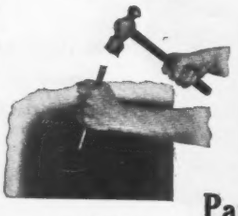
REPLACE WITH HOMER COMMUTATORS

Maintain original equipment quality by using Homer Commutators for all replacements. We use highest grades of raw materials—"Rome Quality" Hard Drawn Copper Bars—Amber "Micanite" Segment Insulation. We never cut quality to meet price competition.

Write for our new folder on Commutators.

THE HOMER COMMUTATOR CO.,
4748 Hough Ave., N. E.
Cleveland, Ohio

THE HOLE STORY



JIFFY CUTTER
Cuts clean round holes thru steel boxes, slate or marble switchboards. Adjustable Diameters ¾" to 6".
QUICK—EASY—ACCURATE

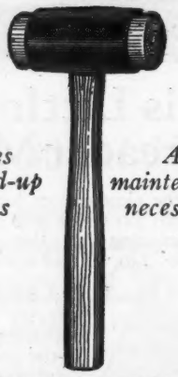
The Old Way Slow and costly

Paul W. Koch & Company
23 So. Wells St., Chicago, Ill.

The Jiffy Way Quickly and Easy

A Hard Blow Without Injury!

"Chicago Rawhide"
Mallets and Rawhide-faced Hammers



Saves battered-up parts

A maintenance necessity

Will transmit an effective blow without damage to the most delicate surface.
But the blow is not more destructive to the tool itself than to the object to which it is applied—therefore, doubly economical.

The Products of our manufacture include:

Belting—Lace Leather—Belt Lacing
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The Chicago Rawhide Mfg. Co.
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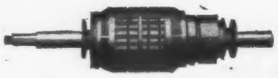

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Reshafting, Bearings, Coils, Commutators, Fields, Brushes, Special parts to order, etc.

Large factory—150 skilled workers—28 years' experience. Heavy difficult work our specialty. Electrical Engineers and Road Men.

Send for repair price lists.

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Direct Current Generator Brushes

HIGH SPEED

Undercut	Corliss R-11
Non-Undercut	Corliss L-14

These applications represent standard generators under normal operating conditions. There are several additional grades to cover all general and special requirements.

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CORLISS CARBON COMPANY
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Largest Exclusive Brush Manufacturers in the World

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Have a use in every industry. Perhaps some of the applications shown in our new sixty-page catalogue will speed up production and lower the number of rejects in your plant.

Write today for this free Electric Oven Reference.

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Minneapolis, Minn.
Electric Ovens for all purposes

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Make the motor better than new by using this high-dielectric Magnet Wire.

You can sometimes use a larger wire without reducing the number of turns, because of the better space-factor.

Increased reliability and efficiency are worthy of the consideration of every maintenance man. You can get them with COTENAMEL.

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Designed Especially to Save Time On All Your Rigid Conduit Wiring

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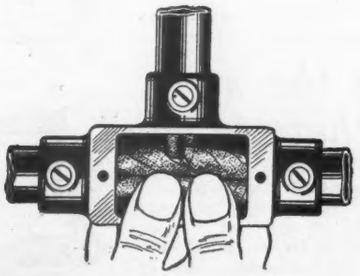
The Fitting That Fits

By saving two and three minutes on every installation you put money in your pocket. This roominess is an exclusive feature in TAPLETS.



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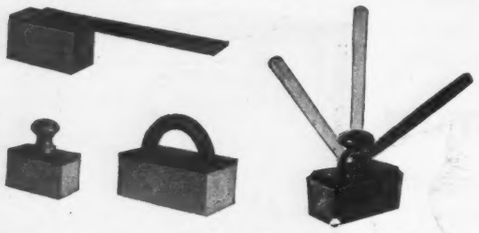
are guaranteed to save you at least three times their cost or we will cancel the bill and pay transportation charges both ways.



Print your Name, Title, Company and address on the margin and mail this in for a copy of our new folder.

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Slotting Files
Slotting Machines
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Gauze Wire Brushes
Portable Blowers

With a CADILLAC Portable Electric Blower

The handiest and most practical blower for blowing dust and dirt out of armatures, field coils, switchboards, machinery, line shafting, stock bins, shelves, etc.
Lowers fire risks. Makes more healthful working conditions. Reduces depreciaton in electrical and other machinery.
Weighs only 6 pounds. Complete in itself and requires no expensive installation or equipment. No condensation as with compressed air.
The CADILLAC BLOWER has proven its worth and is performing successfully with hundreds of uses in shoe factories, cotton mills, grain elevators, coal mines, engravers, printers, wood working plants, textile mills, box factories, and every line of industry.
Write for descriptive folder giving prices and testimonials by leading manufacturers.

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Manufacturers of the Cadillac Electric Vacuum Cleaner
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PHILADELPHIA

STEEL SHELVING
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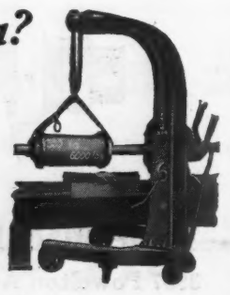
If one man with the aid of a **"Canton Portable Floor Crane and Hoist"** can pick up and walk away with a two ton load, you will agree that a lot of time is saved by its use. It will pay for itself, in a few months, and be a source of satisfaction to all concerned.
Write for Our Booklet Today



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Canton, Ohio
New York Office, 203 E. 15th St.

You're having brush trouble

CORRECT IT
USE LE CARBONE CARBON BRUSHES

They talk for themselves

COST MORE PER BRUSH
COST LESS PER KW.H.

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Where space is limited

Use Minibreakers

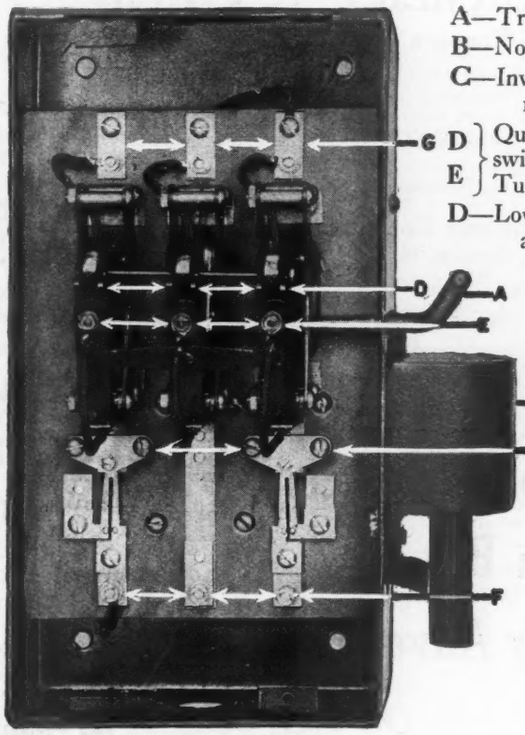
The smallest, most economical across-the-line starter for Alternating Current Motors up to 1 H.P., 110 volts, single phase; 5 H.P., 220-440 and 550 volts, two and three phase.

Minibreakers give both at starting and running complete protection, are full automatic (trip free from the handle), have inverse time element overload protection, no voltage release and are arranged for emergency trip from remote points.

The use of Minibreakers eliminates the blowing of fuses, increases production and insures continuity of service.

A well protected motor is a credit to the electrical department and a satisfaction to the management.

Minibreakers offer the best possible protection obtainable at the lowest cost.



Type CS 3 pole Minibreaker Cover Removed

220 volts with no voltage release and emergency trip.

Dimensions—

6¼x13⅜x5½, with fuses.
6¼x11½x5½, without fuses.

List price $22.50.

Quantity discounts.

We also Manufacture:

Minibreakers for direct current across-the-line motor starting up to 1 H.P. 110 volts and 220 volts, and as motor protective devices only up to 2 H.P., 110 volts and 5 H.P., 220 volts.

We invite orders for sample Minibreakers for test operation. Be sure to give name plate motor reading.

Miniature Breaker Company, Inc.

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Miniature Breaker Co., Inc., Long Island City, N. Y.
Please send me copy of your bulletin.
Name .....
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We use A.C. D.C. Motor.
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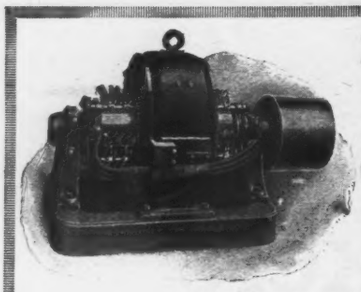

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Motor Generator Sets

For Electroplating
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ALLAN POLYPHASE ARC WELDERS

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SPECIAL TRANSFORMERS

For Every Purpose

in your development work—in your laboratory—in any factory work requiring transformers—we stand ready to assist you in the design and in the custom-making of the exactly right transformer for you.

Send us your specifications

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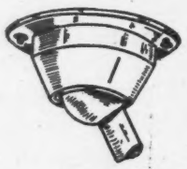

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SWIVEL HANGER

Catalog No. 451
Semi-Swing 45°
List Price 45c

Fits a 4-inch outlet box and will hang vertically even though box is tilted 45 degrees.

Especially suitable for open conduit work under sloping or saw tooth roofs.

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6000 POUND
ELECTRIC LIFT TRUCK

Will pick up and deliver more materials day after day at less cost than any similar truck.

Request details as to this new Special, illustrated in Bulletin A535

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BROWNING LOOP AND FIELD WINDER

Produces loops 25% faster than otherwise possible. A ruggedly built machine with two power shafts, three speeds on each. Embodies perfect control with instant start and positive stop. Winding head eliminates all waste ends.

BROWNING COIL SPREADER

Skilled operators spread 120 coils per hour, with ease, and secure most perfectly shaped coils possible to make. Coil holders and knuckle holders exert positive grips. Special "kick-up" attachment on knuckle. Browning Equipment, the Armature Winder's friend.

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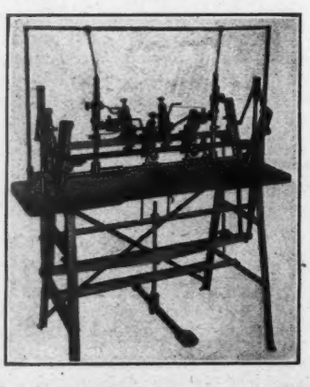


Triumph increases facilities for big motor production

HERE is unusual evidence of Triumph's newly expanded facilities for building heavy duty motors in sizes from 50 to 200 h. p.

Sixteen 75 h. p. slip ring motors like the four above have just been built by Triumph for one of the largest paper mills in the world, The Champion Coated Paper Company, for application to sixteen giant pulp beaters in their mill at Hamilton, Ohio.

With these Triumph motors, this mill is converting its battery of pulp beaters from steam to automatic motor drive and push-button control, with obvious savings and increased efficiency.

Triumph's capable staff of designing engineers, skilled factory personnel, and modern shop equipment are at your service in the production of motors of varied types in all sizes from 1 to 200 h. p.

Experienced Triumph application engineers are conveniently located in the larger cities, ready to bring to your conference table Triumph co-operation in solving the motor problems that arise in powering your plant for maximum efficiency.

This picture of the main production floor of the Triumph factory suggests the preparedness of the Triumph organization to efficiently and economically meet your motor requirements.

THE TRIUMPH ELECTRIC COMPANY

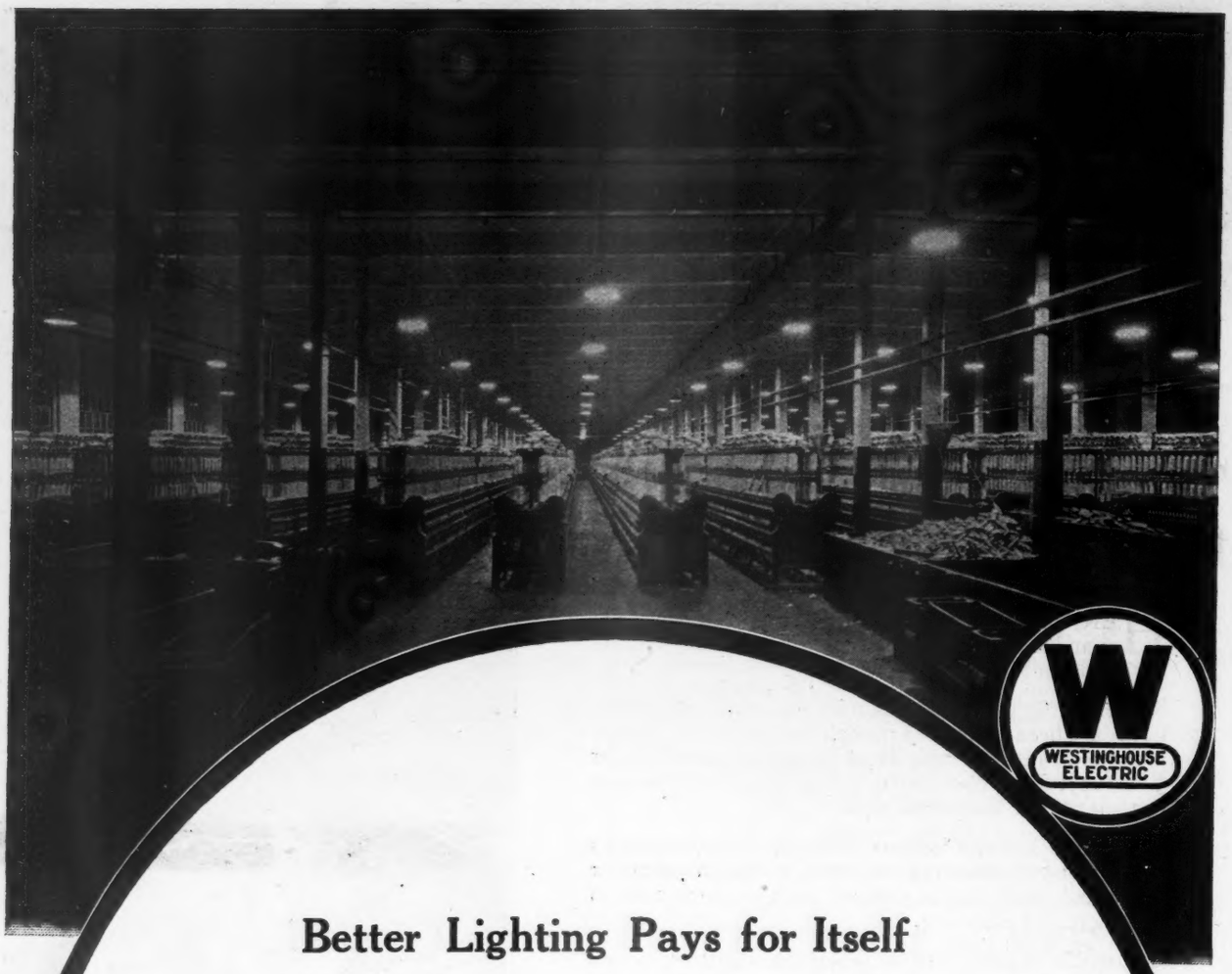
CINCINNATI, OHIO

OFFICES IN PRINCIPAL CITIES

A. C. MOTORS—Squirrel Cage, Slip Ring, and "TR" Self Start Types
D. C. MOTORS—Type "F" Steel Frame and Constant Speed and Adjustable Speed Types

TRIUMPH

POWER-SAVING HEAVY-DUTY MOTORS



Better Lighting Pays for Itself

Good lighting not only saves maintenance money, but it also helps you obtain higher earnings for your investment because it produces definite and measurable increase in production. The average results, computed from records made in hundreds of plants where the lighting conditions have been improved, show production increases of 12 per cent. In addition, spoilage was decreased 23 per cent and accidents decreased 25 per cent.

The investment required to produce these and many other benefits is so slight that in practically all cases it is the lowest part of the overhead charge. The manufacturer who tries to cut the cost of this lowest item saves but a few dollars at the most, and he does so at the expense of the two largest cost items on the list—labor and material.

Westinghouse Electric & Manufacturing Co.

George Cutter Works, South Bend, Indiana

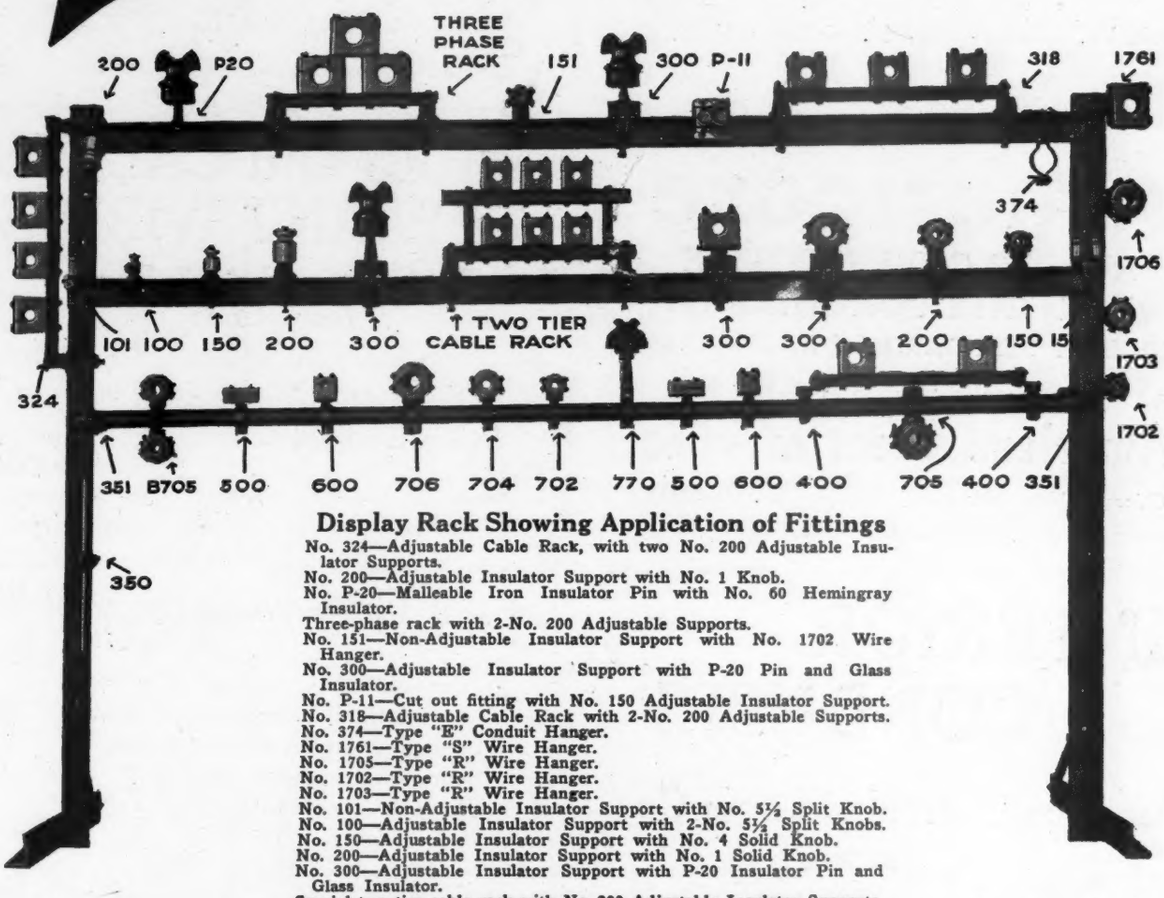
Sales Offices in All Principal Cities of the United States and Foreign Countries

Westinghouse

ELECTRICAL FITTINGS

Wayman

Stronger Fittings with Longer Life and Lower Costs



Display Rack Showing Application of Fittings

No. 324—Adjustable Cable Rack, with two No. 200 Adjustable Insulator Supports.
No. 200—Adjustable Insulator Support with No. 1 Knob.
No. P-20—Malleable Iron Insulator Pin with No. 60 Hemingray Insulator.
Three-phase rack with 2-No. 200 Adjustable Supports.
No. 151—Non-Adjustable Insulator Support with No. 1702 Wire Hanger.
No. 300—Adjustable Insulator Support with P-20 Pin and Glass Insulator.
No. P-11—Cut out fitting with No. 150 Adjustable Insulator Support.
No. 318—Adjustable Cable Rack with 2-No. 200 Adjustable Supports.
No. 374—Type "E" Conduit Hanger.
No. 1761—Type "S" Wire Hanger.
No. 1705—Type "R" Wire Hanger.
No. 1702—Type "R" Wire Hanger.
No. 1703—Type "R" Wire Hanger.
No. 101—Non-Adjustable Insulator Support with No. 5½ Split Knob.
No. 100—Adjustable Insulator Support with 2-No. 5½ Split Knobs.
No. 150—Adjustable Insulator Support with No. 4 Solid Knob.
No. 200—Adjustable Insulator Support with No. 1 Solid Knob.
No. 300—Adjustable Insulator Support with P-20 Insulator Pin and Glass Insulator.
Special two tier cable rack with No. 200 Adjustable Insulator Supports.
No. 300—Adjustable Insulator Support with No. 1761 Type "S" Wire Hanger.
No. 300—Adjustable Insulator Support with No. 1705 Type "R" Wire Hanger.
No. 200—Adjustable Insulator Support with No. 1704 Type "R" Wire Hanger.
No. 150—Adjustable Insulator Support with No. 1702 Type "R" Wire Hanger.
No. 151—Non-Adjustable Insulator Support with P-15-2 Cleat Fitting.
No. 351—Type "C" Conduit Hanger.
No. B-705—Two wire bus fitting.
No. 500—Two wire cleat fitting for 1¼" pipe.
No. 600—Single wire cleat fitting for 1¼" pipe.
No. 706—Type "R" Bus Support.
No. 704—Type "R" Bus Support.
No. 702—Type "R" Bus Support.
No. 770—Type "H" Support with P-20 Insulator Pin.
No. 500—2 wire cleat fitting for 1¼" pipe.
No. 600—Single wire cleat fitting for 1¼" pipe.
No. 400—Cable Rack attachment for 1¼" pipe.
No. 705—Type "R" Bus Support.
No. 351—Type "C" Conduit Hanger.
No. 350—Type "C" Conduit Hanger.

A new Folder just off the press describes these fittings in detail—write for a copy—it's free.

Wayman Electric & Mfg. Co.
East Palestine
Ohio

LEADERS—EVERY ONE OF THEM ALL LABOR SAVING DEVICES

SALAMANDER WIRES and CABLES

The highly desirable finish on Salamander wires and cables is only obtained by using long asbestos fibres. These fibres do not require a cotton thread as a carrier during the insulating process, thereby avoiding the tendency of opening.

The resulting Salamander insulation gives a smooth, hard continuous wall.

YORK INSULATED WIRE WORKS
of General Electric Co.
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BARE AND INSULATED WIRES

WEATHER-PROOF TRADE MARK "O.K." LINE AND HOUSE WIRES

"OK" Weatherproof Wire
"Parac" Rubber Wire
Slow Burning Wire
Bare Copper Wire

PHILLIPS WIRE COMPANY
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RUBBER COVERED WIRE
FOR INTERIOR WIRING
HIGHEST STANDARD OF EXCELLENCE
Send for descriptive book

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WIRES and CABLES For PLANT WIRING

Rubber, Cambric & Paper Insulations
All Sizes *All Services*
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Get that wire—*when* you want it!

For your repair work you want your orders filled promptly. We carry complete stocks of round magnet wire all insulations sizes No. 8 and finer. Call on us when you need wire quickly.

American Enameled Magnet Wire Co.
Muskegon, Mich.

DUDLO QUALITY DIDN'T JUST HAPPEN

but is the result of years of painstaking effort towards improvement. Specialization plus large and continuous production are responsible for the reasonable cost of Dudlo wire and coils.

Write today for samples and quotations

Dudlo Manufacturing Co., Ft. Wayne, Indiana
Western Representative: A. S. Lindstrom, 111 New Montgomery St., San Francisco, Calif.

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Magnet Wire and Windings

An Offer to Maintenance Men

The men responsible for proper maintenance are the best judges of insulations.

But frequently, to secure advantageous prices, they are asked to order large quantities of insulations on the strength of some factory tests.

Service test is the one that counts, and to enable you to see for yourself the advantage of any Sterling product ,you can secure it in small quantities for test, and at small cost.

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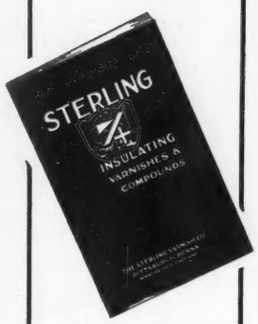
A book you need every day



Catalog D is an invaluable aid to the man concerned with motor maintenances. It contains specific data for your use in coping with insulation problems. Send for it.

Try a test of one Sterling insulation, to see the advantages—here is one you use regularly:

STERLING BLACK ARMATURE LACQUER (a slow air drying varnish, or rapid baking one which retains its flexibility much longer than ordinary air drying ones). We want you to try this lacquer.

It will show you a new service in a lacquer you use nearly every day—so we'll send you an introductory gallon for $1.35—or 5-gallon can at $1.25 per gallon—you to be the judge.

Get this Book Anyway

It is seldom that you have access to as complete a coverage of insulation problems.

We will gladly mail the handbook free to anyone who is interested in advanced insulation practice. When writing, mention any problems you may have—we'll be glad to help.

STERLING VARNISH

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TRADE A-1 MARK

A-1 MAGNET WIRE

Plain Enamel, Single Cotton Enamel, Single and Double Cotton Covered.

"AMERICAN BRAND"

Weather-proof Copper Wire and Cables
Slow Burning (Und.)
Weather-proof Iron Wire
Slow Burning Weather-proof Copper Wire and Cables
Bare Copper Wire and Cables

Are representative of the highest principles in manufacturing and merchandising in the wire industry.

American Insulated Wire & Cable Co.
Chicago, Illinois

TRADE MARK
"AMERICAN BRAND"
WEATHERPROOF WIRE AND CABLES
HAS NO EQUAL

MICANITE
REGISTERED

INSULATION

For MOTORS, GENERATORS, *and* OTHER ELECTRICAL EQUIPMENT

Micanite Plate supplied for your own moulding or stamping or made to your specifications as tubes, rods, rings, flanges, spools, bushings, washers, sleeves, and as commutator segments in every size, shape, and thickness. Empire Oiled Materials in sheets, tapes, and tubes for a variety of electrical insulations.

Forty page catalog replete with photographs and data on all our insulation products sent promptly on request.

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Founded 1878

OKONITE
TRADE MARK

Incorporated 1884

The Standard for Rubber Insulation

OKONITE PRODUCTS

are available for all electrical purposes.

They have stood the test of time and are recommended by prominent Electrical Engineers everywhere.

- Power Cables (Okonite and Varnished Cambric)
- Submarine Cables
- Parkway Wires & Cables
- Signal Wires
- Car Wires
- Jumper Cables
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- Locomotive Headlight Wire
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- Telephone & Telegraph Wires
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"INSULATED WIRE & CABLE"

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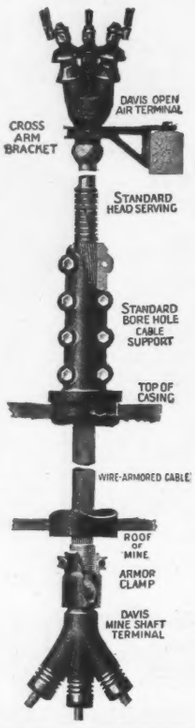
Wires, Cables and Cable Accessories



make for efficiency and dependability in the installation and operation of electric transmission systems.

The illustration shows how one or more electric cables can be safely and easily installed in the borehole of a mine or tunnel, or in any vertical position, by using STANDARD Borehole Cables with Cable Supports and Indoor and Outdoor Cable Terminals. A separate support is required for each cable.

For further information ask for Bulletin 700.

Standard Underground Cable Co.

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Thomas Quality Insulators and Transmission Line Fittings

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When you want to anchor one cable and take a branch wire off the anchored cable

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Consists of an elbow and clevis for the strain insulator—so arranged that pull is exerted on one cable only.

There are several types of Dossert Cable Anchors shown in the 15th Year Book, which catalogs the whole line.

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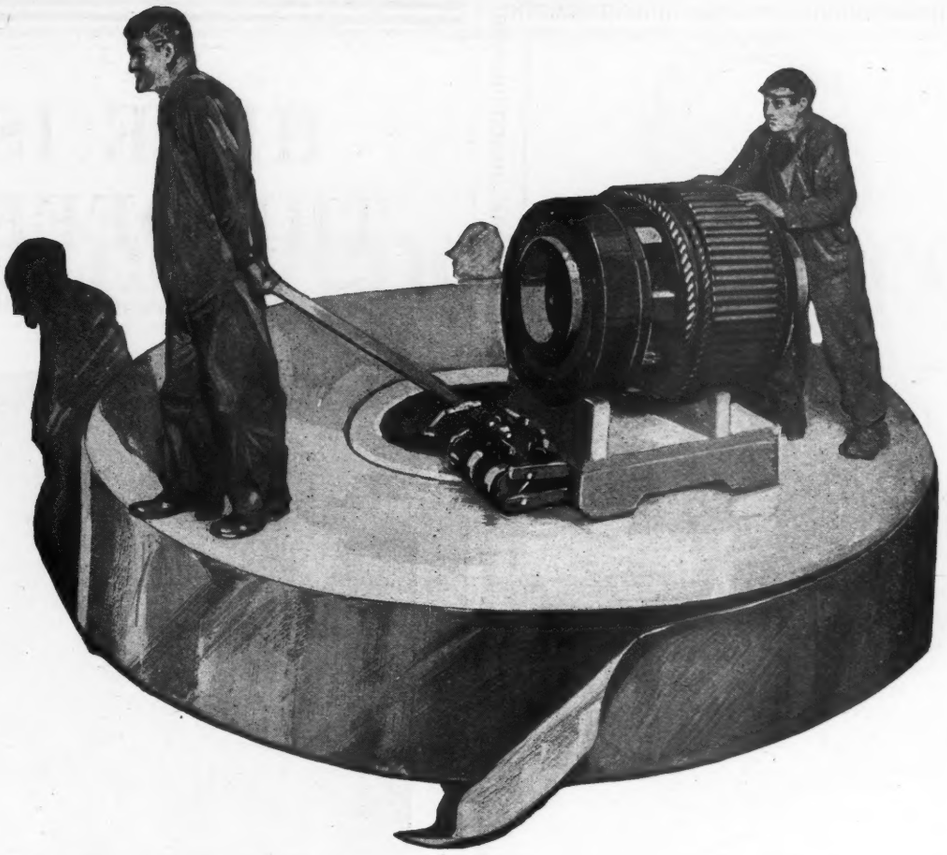


Putting Insulation Requirements on a Firm Foundation

It is not enough for a motor manufacturer or an industrial plant to standardize on one kind of varnished insulation simply because he buys it from the largest manufacturer of that product such as "Irvington."

It is not enough that today the majority of high tension insulated wires and cables in the United States are protected by Irvington Black Varnished Cambric.

But when we say that in comparison with other insulation, Irvington Black Varnished Cambric has 30% higher dielectric strength; 100% better heat resistance; 100% more alkali and acid resistance; 200% better aging qualities; 200% more resistance to oil than yellow varnished cambric, no further explanation of the foregoing facts is necessary.

Like many other manufacturers, you can build on a firm foundation, by standardizing on Irvington Black Varnished Cambric Tape.

IRVINGTON VARNISH & INSULATOR CO.

Irvington, New Jersey.

Established 1905

Sales Representatives:

Mitchell-Rand Mfg. Co., New York
T. C. White Electrical Supply Co., St. Louis
E. M. Wolcott, Rochester
F. G. Scofield, Toronto
L. L. Fleig & Co., Chicago
Consumers Rubber Co., Cleveland
Clapp & Lamoree, Los Angeles and San Francisco

Seven Factors of Quality

High Dielectric Strength
High Resistance
Flexibility
Non Hygroscopic
Heat Resisting
Chemically Neutral
Maximum Elasticity

Selwa

Selwa is the large hole in the ground that the Kaffir digs as a storehouse for his grain, etc. The entrance is covered with grasses so that raiders will have a hard time finding the hiding place.

Our artist has deftly depicted an unthinking person, just above such a storehouse and registering bewilderment.

And the title to the picture reads "Get below the surface when you want what you want." If you're bewildered on commutation—get below the subjoined Morganite trademark (just about an inch due south of here), and you'll find the name of a brush engineer who will dig below surface appearances and prescribe the right Morganite brush to make operators feel that after all, perhaps life is worth while.

Morganite Brush Co., Inc.

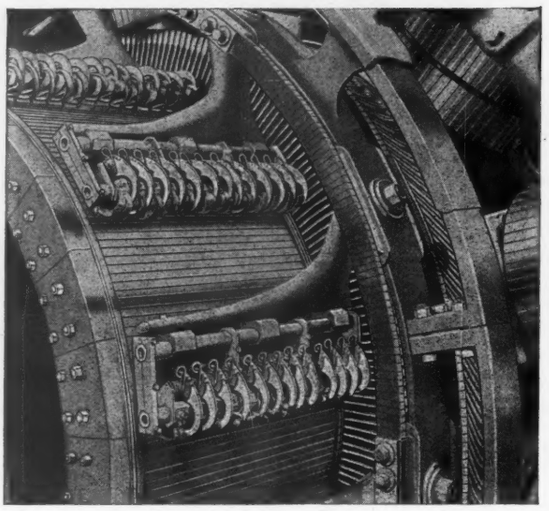
Main Office and Factory:
519 West 38th St., New York

DISTRICT ENGINEERS AND AGENTS:

Pittsburgh, Electrical Engineering & Mfg. Co., 909 Penn. Ave.
Cincinnati, Electrical Engineering & Mfg. Co., 607 Mercantile Library Bulding.
Cleveland, Electrical Engineering & Mfg. Co., 422 Union Building.
Buffalo, Electrical Engineering & Mfg. Co., 409 Lafayette Building.
Philadelphia, Electric Power Equipment Corp., 412 North 18th St.
Baltimore, O. T. Hall, Sales Engineer, 1926 Edmondson Ave.
Revere, Mass., J. F. Drummey, 75 Pleasant Street.
Los Angeles, Special Service Sales Co., 502 Delta Building.
San Francisco, Special Service Sales Co., 202 Russ Building.
Toronto, Can., Railway & Power Engineering Corp., Ltd., 131 Eastern Ave.

HERE IS THE OFFER

That has made customers for us



Let us equip a generator or motor for you with

Reaction Brush Holders

—their final acceptance will be subject to your approval after any reasonable period of operation!

They keep your commutators from running hot.
They eliminate destructive sparking.
They keep brushes from wearing grooves.
They make quiet running machines.

SAVE MONEY—take advantage of this offer today—NOW!

The Baylis Company

50 Nelson Street, Bloomfield, N. Y.

Emergency Service

WHEN your motor or generator fails because of brush trouble—when you need brushes on short notice for any reason—

Write—Phone—Wire

to our nearest brush plant for *immediate* service.

NATIONAL CARBON COMPANY, INC.
CARBON PRODUCTS DIVISION

New York, N. Y.
237 East 41st Street
Phone: Vanderbilt 10471

Cleveland, Ohio
P. O. Box 400
Phone: Lakewood 4000

Chicago, Ill.
560 West Congress Street
Phone: Harrison 0143

Pittsburgh, Pa.
7th Floor, Arrott Power Bldg., No. 3 Barker Place
Phone: Smithfield 0740-0741

A 14" leather motor belt transmitting 100 H. P. while running 31 inches slack. NO SLIP! First treated with Cling-Surface in 1912.

Slack Belts Give Full Power--

Tight belts take a toll from production that is as unnecessary as it is inefficient. This toll must be reckoned with when combating the wastes of production. It is far-reaching,—including losses of power from friction and the necessity of overcoming the increased dead load; a further drag on the pulleys that heats bearings and adds to lubrication costs; a shortening of the life of expensive belting.

Slack belts give full power, and prevent these wastes. Slack running belts, smooth running belts, steady running belts,—these are the conditions that will result from Cling-Surface treatments. And only from Cling-Surface treatments will these conditions result. It is a fact that no other treatment nor method has given results equal to Cling-Surface in the past 27 years.

Today, tension in the form of tight belts has no place in any well ordered plant. Tension has no other use than to try to prevent belt slip; in no case is it ever entirely effectual in its prevention. Why then suffer the evil effects resulting from tension when a little Cling-Surface stops slipping absolutely?

The lubricating qualities of Cling-Surface make belts mellow and pliable; its preservative qualities make them strong, durable and waterproof. There is imparted to the surface of the belt a clean, clinging, cohesive grip, while to the fibres of the belt is given renewed life and vigor. That is the action of Cling-Surface,—the action of a **pure belt food** and not just a superficial dressing.

Actions speak louder than words. Let us send you a tin on trial. Put Cling-Surface into action. When you get results, you may act on our invoice.

Clip and Mail NOW

Cling-Surface Company

1020 Niagara Street, Buffalo. N. Y.

Gentlemen—You've got me interested in your Slack Belt Treatment. Send us a trial 3 or 5 gallon

Name: ..... tin of ☐ Light

Company: ..... ☐ Medium

Address: ..... ☐ Heavy

CLING-SURFACE

(Check square ☐ for consistency desired) I.E. 12-23

1-gal. tin..$3.50 ea. 3-gal. tins..$3.40 gal. 5-gal. tins..$1.25 gal.

Be sure to see the February 1924 issue

A Special Number

ON NEW

INDUSTRIAL EQUIPMENT

Advertising Forms Close

January 20th

INDUSTRIAL ENGINEER

Old Colony Building *CHICAGO*

As Smooth as Gun Barrels

Dependable Insulation is one of the reasons for the trouble-free service given by Master Repulsion Induction Motors. The slots in Master stator cores are as smooth as gun barrels. The windings are *completely* enclosed in double-thick compartments of Fish Paper and Empire Cloth. All conductors have sleeves for extra protection.

Seven times every Master Motor receives breakdown tests of from 1,100 to 1,500 volts. A most thorough impregnating process insures windings that are moisture resisting.

If you buy motors for application on your product or for individual drive in your plant, Master Motors can save you money. Write today for detailed information.

THE MASTER ELECTRIC CO.
450 First St. Dayton, Ohio

MASTER
40° MOTORS ⅛ to 1½ H. P.

Single Phase Motors

—And good ones too, no matter what the job is. Valley Single Phase Repulsion Induction Ball Bearing Motors are made in sizes from 1-6 to 5 h.p. Also Polyphase Motors from 1-4 to 40 h.p.

VALLEY ELECTRIC COMPANY
3157 S. Kingshighway, St. Louis, Missouri.

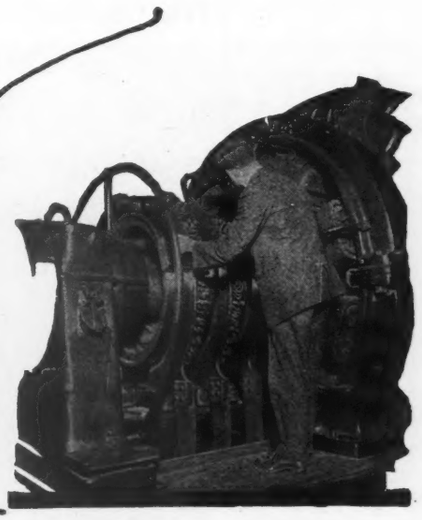
Representatives in Principal Cities.

Valley Motors

—the Ideal is not found in Nature

We have to make it up specially, and in this way only can we know and guarantee its uniform quality. The use of lubricants on bearings is no more a necessity than the use of the Ideal on the commutators or slip rings. Both are subject to wear, and neglect is serious in either case. A few moments daily with the Ideal saves many hours and much trouble and expense for major repairs if the commutators are neglected. Demonstrate this to your own satisfaction at our expense. Use the coupon below.

IDEAL COMMUTATOR DRESSER CO
5341 N. Western Ave. Chicago, Ill.



free trial offer

Ideal Commutator Dresser Co.
5341 N. Western Ave., Chicago.

Gentlemen: Please send me an Ideal Commutator Resurfacer for free trial. If I like it I'll pay for it. If I don't like it I will return it—the trial will have cost me nothing. I want to use it on equipment as follows:

Approx. R. P. M.....Diameter of Commutator or Ring.....

Approx. width of Commutator or Ring surface.....

Approx. distance between brush sets.....Condition.....

Collector Ring or Commutator material.....

Name..... Position.....

Company.....Company Address.....

City..... State.....

12-1-23

FAIRBANKS-MORSE

ball bearing motors

Motor failures, due to bearing trouble, practically eliminated. The bearings last as long as the motor. Positively dust-proof. Need lubrication but once a year. Reduce power bills, cut production costs

FAIRBANKS, MORSE & Co.
CHICAGO *Pioneer Manufacturers of*
ball bearing motors

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A Holiday Gift

That he is sure to appreciate—a year's subscription to "Industrial Engineer."

Send us his name and address and $2.00 — we'll do the rest.

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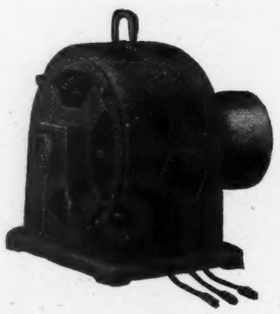
Burke Type E M Induction Motor



Put a Burke Motor Anywhere

Burke Motors can be adapted for service any place and in any position. They can be suspended from side walls or ceilings by merely turning the bearing brackets. They have been applied by thousands in every industry where reliable electric drive is required. Ask for particulars.

We also manufacture Alternators, Generators, Motor Generator Sets, Arc Welding Equipment and Transformers.

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ERIE, PA

Sales Offices: Buffalo, Cleveland, Detroit, Erie, New York, Philadelphia, Pittsburgh. Sales Agencies: Underwood Electric Co., Cincinnati; W. T. Osborne, Kansas City; Coast Equipment Company, San Francisco, Cal.

How to keep motors on the job—longer

That's what we started to find out when we went into the field to get first-hand facts before designing Type AA Reliance Induction Motors. Twenty-five electrical engineers in ten lines of industry showed us just what weak spots were revealed in their plants. They told us what induction motors must stand and what from their experience was necessary to overcome their difficulties.

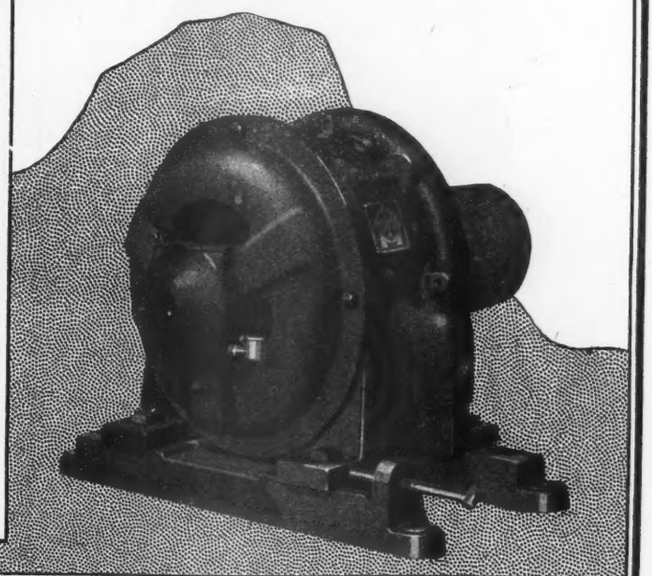
Stator insulation, bearings and rotor construction were features on which these men were unanimous in placing much emphasis. Following their recommendations we have built Type AA motors to give satisfaction in these vital spots.

Before placing this new line of motors on the market, the reliability of Type AA motor construction was proved by two years of service in 24 plants.

For the complete story of the design of this new motor and details of manufacturing, get our Bulletin 5018.

RELIANCE ELECTRIC & ENGINEERING CO.
1051 Ivanhoe Road, Cleveland, Ohio
Branches: Boston, New York, Philadelphia, Pittsburgh, Chicago, Detroit, Cincinnati

We specialize in motors sizes ½ to 200 h. p. constant and adjustable speed D. C., squirrel cage and slip ring A. C.



Type A-A RELIANCE Induction Motors

Baldor Electric Motors
Ball Bearing

Single Phase Repulsion Type

Direct Current

Polyphase

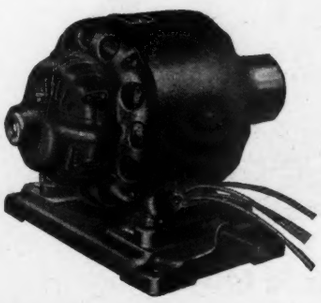
Horizontal & Vertical Design

Semi and Totally Enclosed

Back Geared

Superior in Quality
Competitive in Price

Baldor Electric Co.
4351-55 Duncan Ave., St. Louis, Mo.



Jeannin Single Phase Repulsion Induction Motors

¼ to 5 H. P.

The Jeannin Electric Co., Toledo, Ohio

The New "MARTIN" ROTARY CONVERTER

Economical Battery Charging with the New MARTIN Converter

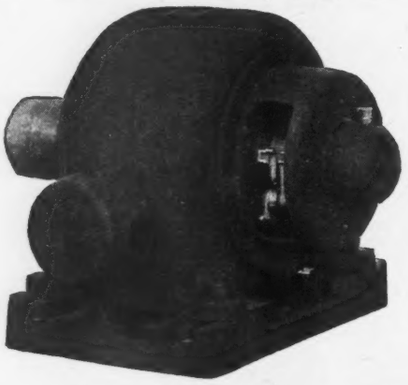
The "Martin" Rotary Converter is self-starting and has been designed to replace motor generators and rectifiers for charging batteries. It eliminates the loss of the motor end of motor-generator sets and the high maintenance cost of Mercury rectifiers.

The ease with which these converters can be started and operated recommends their use in a variety of installations. They are as simple to start as a motor and require minimum attention.

A very compact unit, self-contained; these advantages reduce the cost of installation.

Complete description sent on request.

Northwestern Electric Co.
408 South Hoyne Ave., Chicago



Crocker-Wheeler

Form L Direct Current

Motors

115, 230 and 550 Volts

Motors ⅛ to 7½ H. P. Generators 0.35 to 5 K. W

TIME TESTED

The C-W Form L is a small motor used in hundreds of ways and known widely for its remarkable durability and trouble proof characteristics. Often subjected to rough treatment and neglect by laymen, this motor has been remarkably successful, not because of any one special feature, but because of the careful design and construction of every detail. And this applies to all C-W machinery. It is the chief reason why Crocker-Wheeler equipment possesses its enviable reputation for reliability.

In small motor generator sets, as belted or direct connected exciters, or wherever small amounts of direct current power are required C-W Form L Generators should be specified.

Crocker-Wheeler Co.

Ampere, N. J.

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Squirrel Cage Polyphase Motors

resulting from experience with other motor products of our works, accounts for their increasing popularity among motor users.

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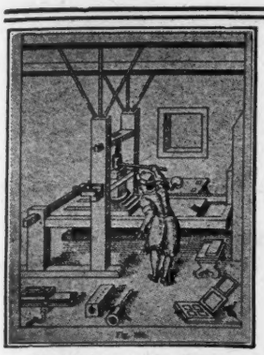
Ratings ⅓ to 15 H. P.



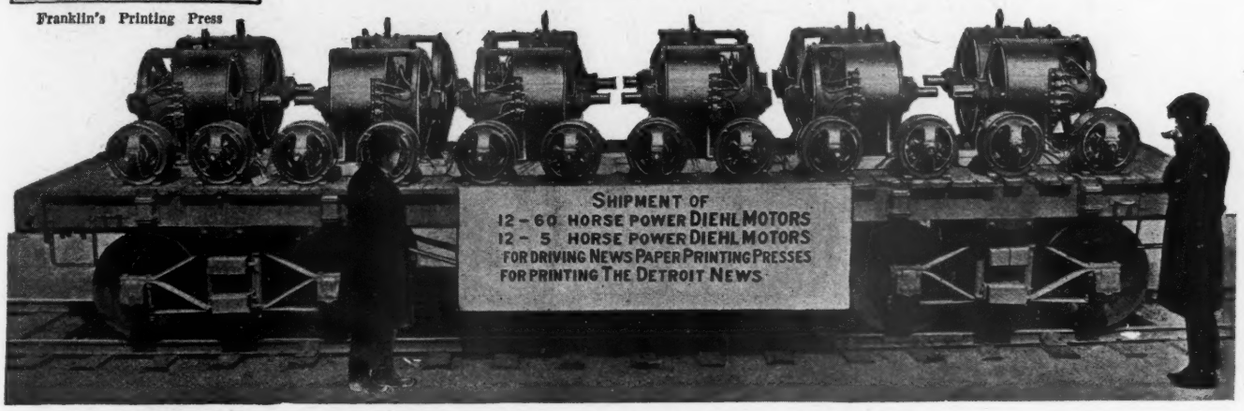
Franklin's Printing Press

Diehl Motors *and the* Modern Printing Press

DIEHL MOTORS with double octuple presses make it possible in a single hour to print huge editions of modern newspapers.

What would Benjamin Franklin have done in his time had he such means of broadcasting the news?

The ancient Town Crier would have lost his job.


SHIPMENT OF
12 - 60 HORSE POWER DIEHL MOTORS
12 - 5 HORSE POWER DIEHL MOTORS
FOR DRIVING NEWS PAPER PRINTING PRESSES
FOR PRINTING THE DETROIT NEWS

This carload shipment of motors (780 hp.) is an addition to 83 motors totalling 1500 hp. already installed by the Detroit News (WWJ)

Diehl TRADE MARK *Write for Bulletins*

Diehl Manufacturing Company
Trumbull Street, Elizabeth, N. J.

Branches: New York Chicago Philadelphia Boston Atlanta

Diehl TRADE MARK

This finger points to economy

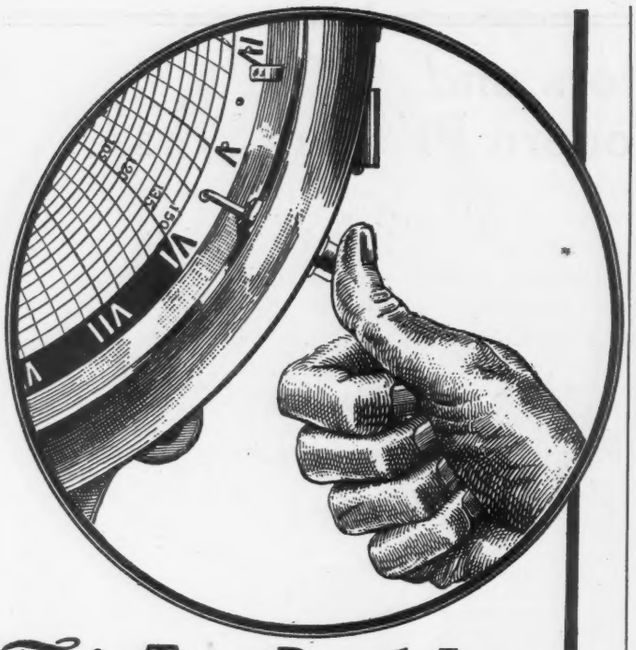
In the operation of drum controllers, starters, compensators—any industrial equipment where controller fingers are used—a tremendous saving is assured by the use of the Triggerlock Reversible Controller Finger. The illustration shows at a glance just what it is like. It will last for years. The renewable tip takes all the wear. Each tip will outwear four ordinary fingers. Renewals take but a moment without removing the finger from the controller. Furnished for all types and sizes of equipment.

Over a million sold.
Ask for catalog.

Illustration at the left shows finger ready to install and with renewable tip unlocked.

This is all you have to scrap when both sides of tip are worn out.

RUSSELL MFG. CO.
814 Bath Ave.
NIAGARA FALLS, N. Y.



This Time Punch Insures Manufacturers Against Waste, Workmen Against Injustice

The operator simply pushes the button when making each inspection of the temperature indicated by red line on the day-and-night chart, and the exact time of inspection is recorded opposite temperature by a small hole punched in the time border of the chart.

Thus the manufacturer is assured of the maintenance of the exact temperature required to turn out products of the highest quality at the lowest cost, without spoilage. For the operator knows that if he neglects to make regular inspections, the dial will show his delinquency.

Columbia
Recording Thermometers

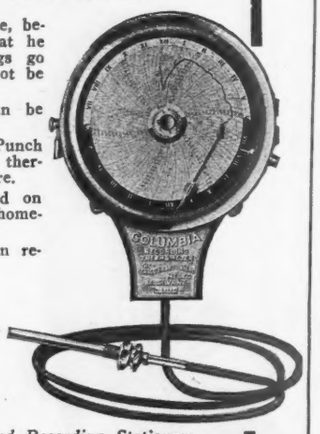
are also a protection for the employee, because they enable him to prove that he performed his duties, even if things go wrong. In this way the blame cannot be put on the wrong man.

Any temperature up to 1000° can be accurately recorded.

Columbia Recorders with the Time Punch cost no more than other recording thermometers without this valuable feature.

The Time Punch is also furnished on Columbia Recording Gauges and Tachometers.

Our interesting Catalog H-6 sent on request. Write for it today.



American Schaeffer & Budenberg Corporation
SUCCESSORS TO
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Manufacturers also of Indicating and Recording Stationary Tachometers for all applications.

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ACCURATE
Within ¼ of 1%

THE unrivalled working standard and precision test instrument.

Made in 3 forms—offering a development in electrodynamometer wattmeters not obtainable in any other similar type of instrument. Its accuracy of ¼ of 1% is guaranteed on either D.C. or A.C. circuits at any power factor and frequency to 133 cycles per second and any wave form. Doubly shielded — effectually protecting it against stray fields. Stands double its normal load capacity. Has double ranges for both current and voltage circuits. Not affected by any ordinary degree of temperature change. Exceptionally small power consumption. Gives indefinite service. Special instruments available for unusually low factors.

Write for Bulletin 2002 giving complete detailed information

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136 Weston Ave., Newark, N. J.

Branch Offices in All Principal Cities

Electrical Indicating Instrument Authorities Since 1888

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STANDARD - The World Over

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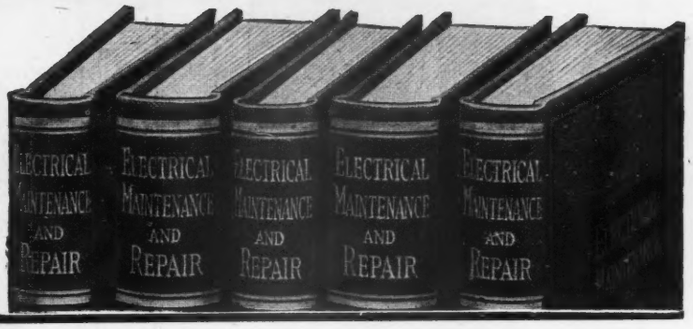
ELECTRICAL MAINTENANCE AND REPAIR
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Electrical Maintenance and Repair—

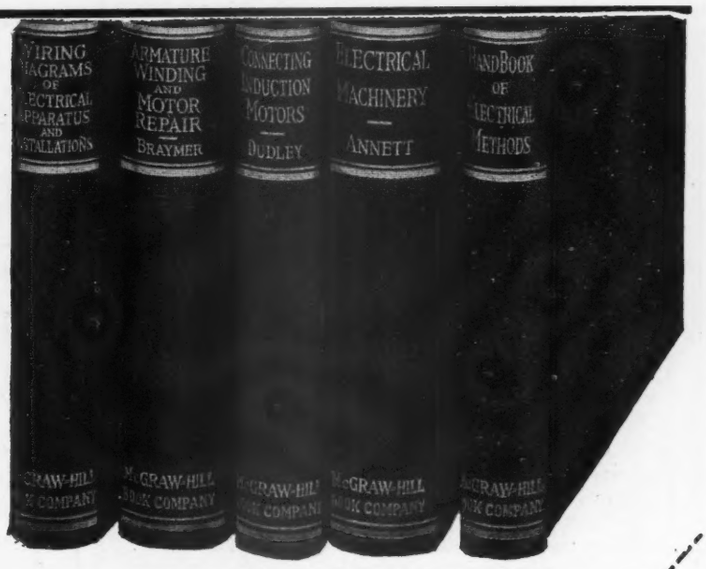
5 volumes—1736 pages—1818 illustrations—library binding

THESE five volumes contain the largest collection of practical methods for electrical repair and maintenance men ever put together in book form.

Every one of the books is jammed from cover to cover with good, sound, how-to-do-it information—the kind you have to have when anything goes wrong.

They cover every phase of electrical repair and maintenance work from armature winding to the correction of brush troubles. And the treatment is always from the practical man's standpoint.

Fundamental laws and rules are discussed when necessary, but there is no hard-to-understand theory or discussion of design. All of the material presented in these five books has been obtained from actual experiences. The library outlines the practical remedies that have been applied by repairmen all over the country in the solving of puzzling electrical problems.



These books tell you

How to replace commutator segments—

How to connect an induction motor winding to meet any condition of voltage, phase, frequency and speed—

How to check this reconnection to know if the motor will operate under the new condition—

How to draw a diagram for any winding—

Ten most common defects in windings—

How to locate defects—

How to figure a new winding for an old core—

How frequency effects winding and r.p.m.—

How performance is affected by a change in winding—

How to find out what the trouble is when a motor or generator will not run—

How to remedy the trouble—

How to keep electrical machines in first-class operating condition—

How to re-arrange a three-wire system to reduce voltage fluctuations—

How to test meters—

How to turn down a commutator—

How to insert spare transformer in star-delta group—

How to remove defective field coils—

And hundreds of other practical methods and kinks

Seven good reasons why you should have these books

1. The five books in this library discuss actual repair jobs and show you step by step what to do when anything goes wrong.
2. They show you how to locate and remedy motor and generator troubles.
3. They show you how to reconnect motors to meet any condition of voltage, phase, frequency and speed.
4. They give you suggestions for preventing electrical machinery troubles.
5. They cover fully the rewinding of motors.
6. They present information that will help you get better service out of your electrical equipment.
7. They give you tables, data, kinks that you will find of priceless value every day on every job.

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If you keep these books after looking them over send us $2.00 in ten days. The balance may be paid in monthly installments of $2.00 until the price of the library—$14.00—is paid. Send for the books today. Fill in and mail the coupon. No money down—no agents. You simply agree to return the books, postpaid, in ten days or remit for them on our convenient monthly payment plan.

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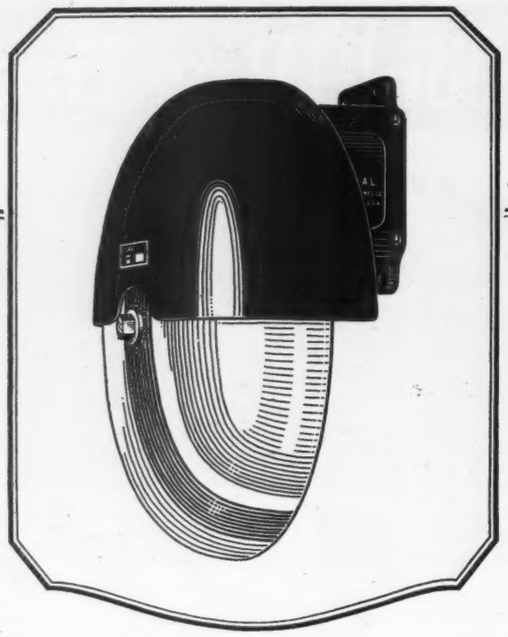

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Vibrating or Single Stroke

of solenoid underdome construction produce the same volume of sound year in and year out—with no adjustments.

"Signal" Weatherproof Bells insure dependable operation under the most severe weather conditions whether it be snow, rain or ice. The weatherproof models are made with special care and pride. Every man in our shop realizes that a bell that fails may cause loss of life or property damage.

While great stress is laid on dependability, "Signal" Weatherproof Bells have a dignified, pleasing appearance. The special bell metal gong insures a pleasant, full-toned, true ring of great signaling power.

All sizes and types mount on our universal outlet box. This feature simplifies installation and makes subsequent changes convenient.

Freedom from adjustment—or maintenance of any kind; thorough reliability; and a tone of unusual carrying power make "Signal" Weatherproof Bells desirable for every signaling purpose.

"Signal" Weatherproof Bells are furnished in 8", 10" and 12" sizes wound for any standard voltage—24 to 250 volts A.C.—6 to 250 volts D.C.

Write for prices and discounts.

SIGNAL
ENGINEERING & MFG. CO.
533 CANAL ST. NEW YORK, N.Y.

That Plant Needs an Autocall!

That plant for whose efficient operation you are responsible should have an Autocall in it!

Either the mechanical paging system, that locates executives wherever they may be;

Or the fire alarm system that brings a capable fire-fighting force into action in the fewest possible minutes;

Or the watchman's supervisory service, by means of which a *chief on the premises* keeps in constant touch with all his men, and uses them like an army to repel dangers, from whatever quarter they may come;

Or some combination of these three services!

Autocall has developed tremendously since it was first introduced as a simple bell-signal system. You really ought to have the latest information clearly in your mind as well as in your data file! *May we tell you about it?*

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Industrial Fire Alarm Service
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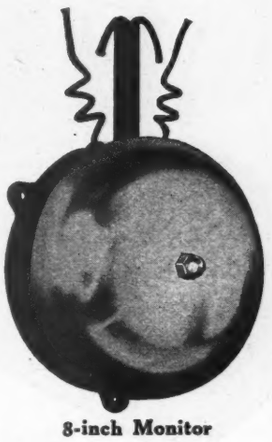

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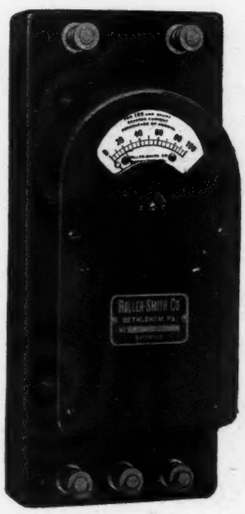

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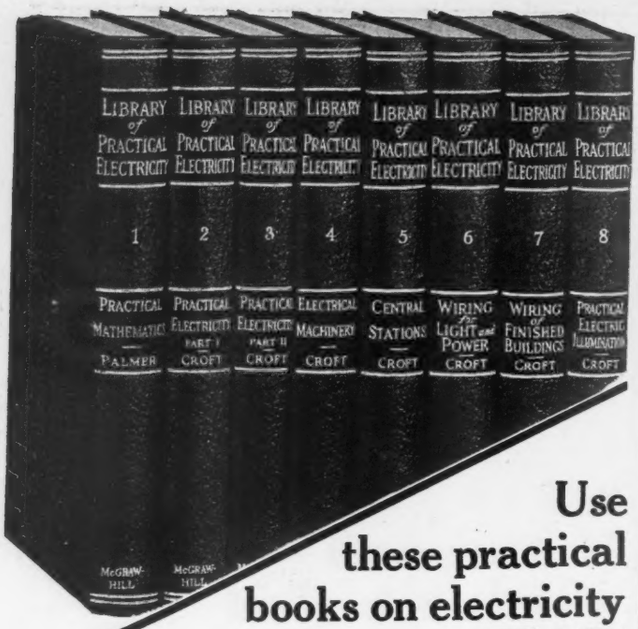
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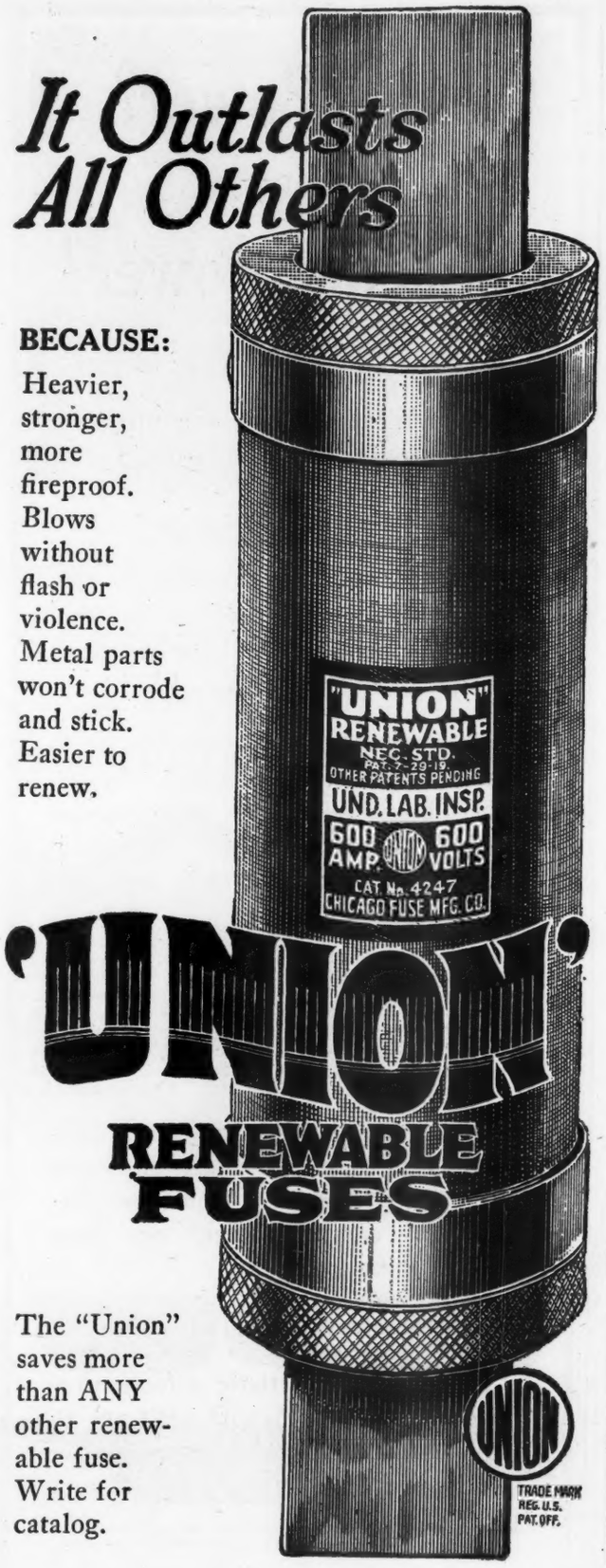

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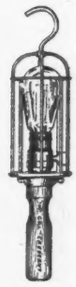

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Lamp Guards
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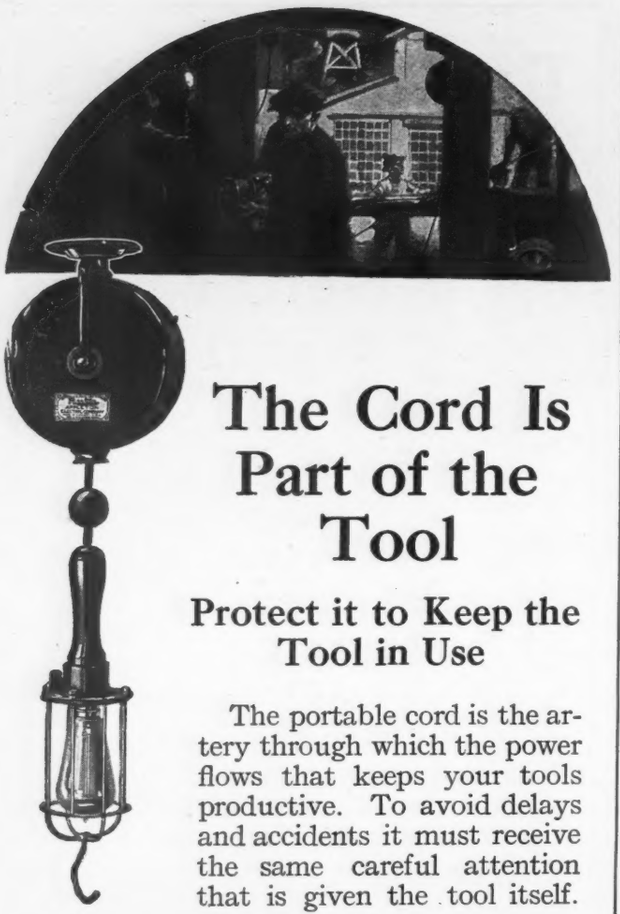

The Cord Is Part of the Tool

Protect it to Keep the Tool in Use

The portable cord is the artery through which the power flows that keeps your tools productive. To avoid delays and accidents it must receive the same careful attention that is given the tool itself.

A **Reelite** will keep your light and power portable cords neatly coiled in its steel container, free from kinks, breaks or tangles. It will pay out the cord as needed and then retrieves it automatically when the job is finished. The action is similar to that of a window shade.

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Which do you want in the factory?

CANDLE POWER is a measure of brightness. It is useful in the physical laboratory for scientific purposes.

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Both science and experience have demonstrated that Cooper Hewitt light, by reason of its peculiar **quality,** has about twice the **seeing** power of ordinary electric light of the same **candle** power.

You don't need a "meter" to tell what kind of light is best for the workman—his output gives the information you want.

Cooper Hewitt light gives full daylight results in all cases—in some cases better results. Don't be mislead by "candle power" or "foot candle" measurements.

Fads may come, and fads may go—

But the true artistic effects produced by Cooper Hewitt light are always in demand by the conservative public, which is the mainstay of your profession.

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CH-194

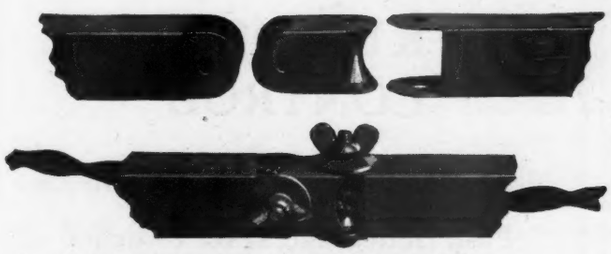
There are 60 "American" Fixtures in this drafting room of the Allis-Chalmers Mfg. Co. at Milwaukee

Adequate Lighting Is as Important as Adequate Lubrication

Numerous shapes and sizes are made possible through various combinations of standard parts. Send for Catalog with illustrations of complete line.

Consider how necessary to profitable operation is the smooth, quiet running of machinery, earning power and keeping down wear. Then think how much easier the human part in production is made, when eyestrain and glare are removed, and workman can proceed with ease and certainty with their work.

American Fixtures, as an adjunct to equal lighting, provides intensive illumination where it helps most.



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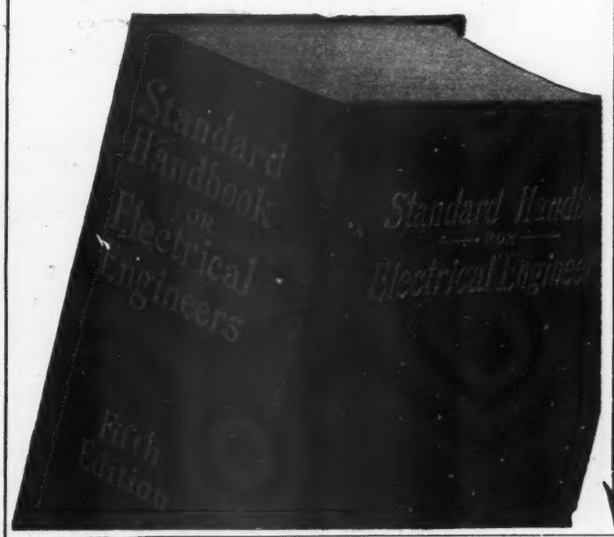

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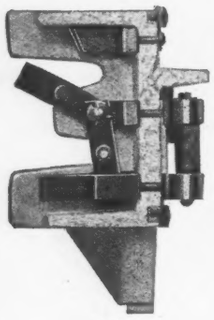

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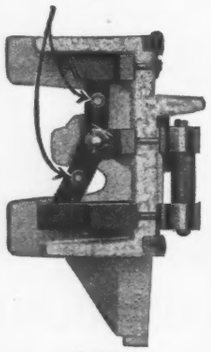

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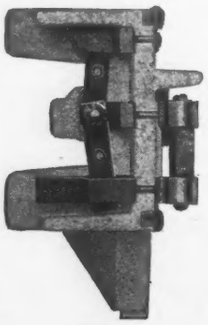

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Here is a simple, yet superior and inexpensive starting device for three phase squirrel cage motors up to 5 H. P., 250 volts. Rugged, yet easily operated, low priced, yet good looking, it forms an attractive and reliable attachment to the finest motor driven machine.

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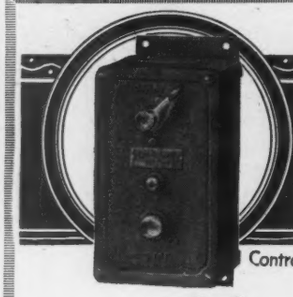

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Safeguards Operator— Protects Machinery!

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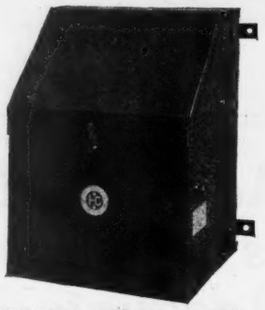

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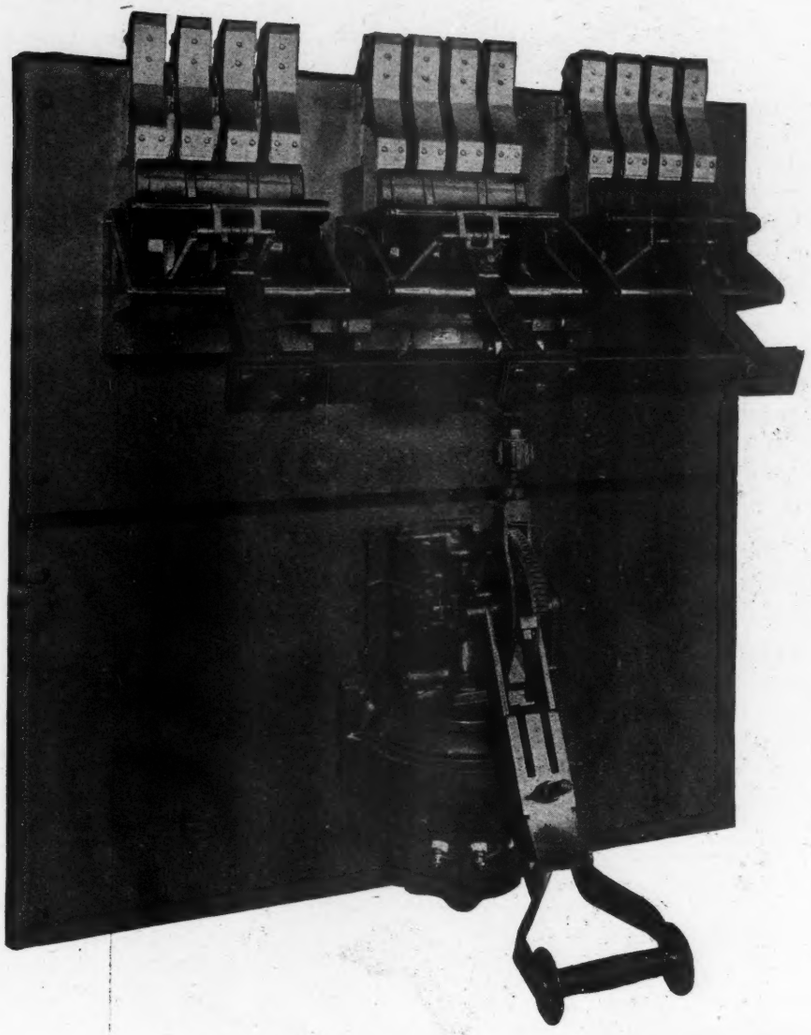

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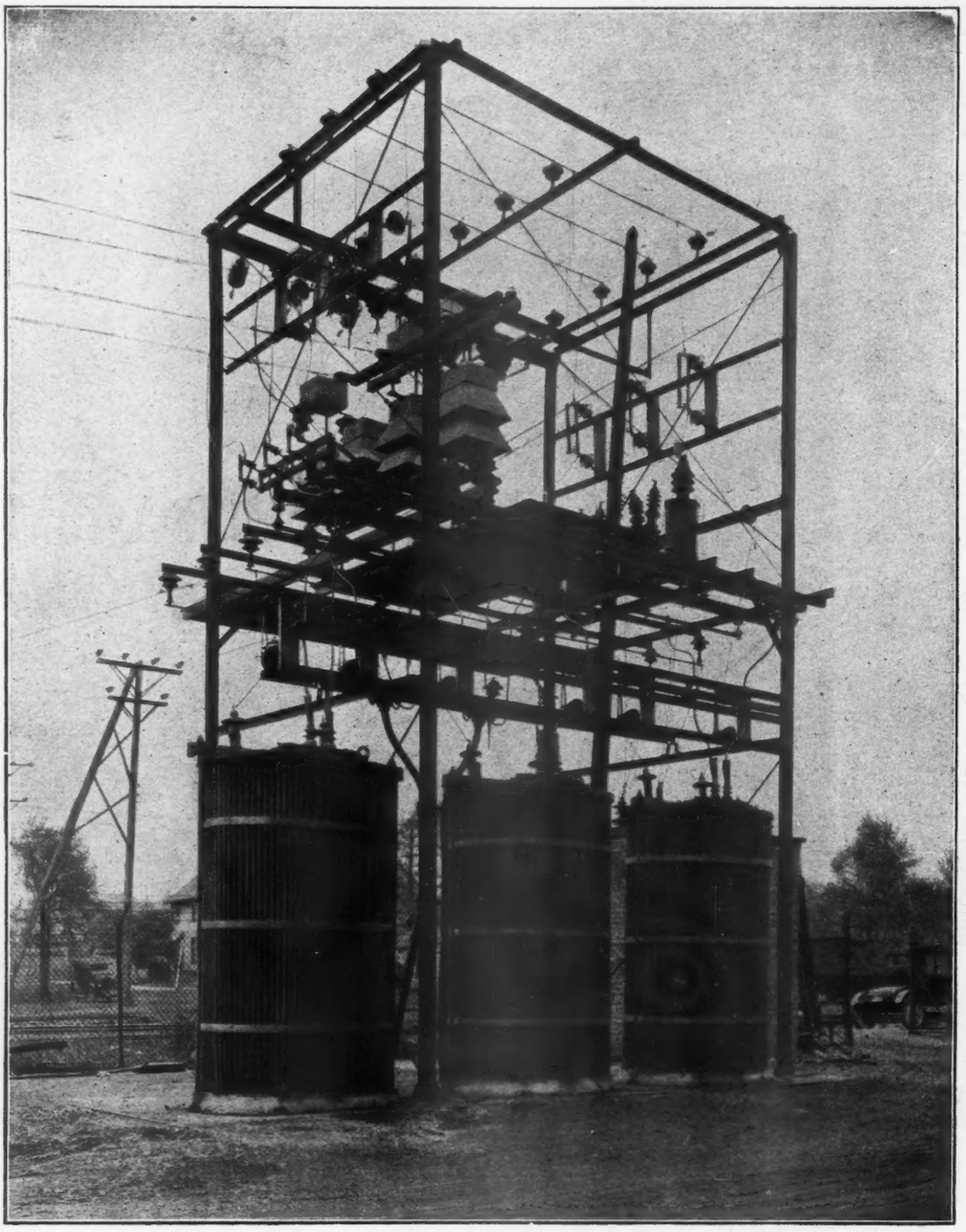

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20	5	G. E., type RC-26A, interpole	1700	1	15	Triumph, comp.	650
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(Continued on page 76)

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(*Continued from page 74*)

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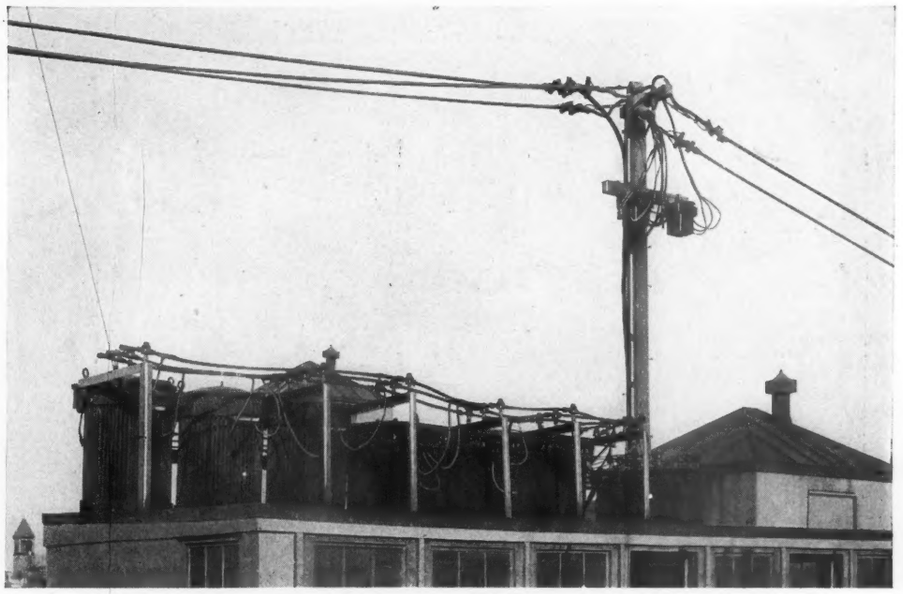

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